AMERICAN ENGINEER AND RAILROAD JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January, 1893.

PUBLISHED BI-WEEKLY AT NO. 47 CEDAR STREET, NEW YORK.

M. N. FORNEY, . . . Editor and Proprietor.
FRANK J. FRENCH, . . . Business Manager.

Entered at the Post-Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Postage prepaid, { U. S., Canada and Mexico, . . $2.50
Single Copies, ...10
Foreign Countries, ... 3.50

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

The paper may be obtained and subscriptions for it sent to the following agencies:
Chicago, Post Office News Co., 217 Dearborn St.
London, England, Sampson Low, Marston & Co., Limited, St. Dunstan's House, Fetter Lane, E. C.
Berlin, Germany, W. H. Kühl, 73 Jäger St.
Paris, Bandry et Cie., 15 Rue des Saints-Pères.

NEW YORK, NOVEMBER 14, 1895.

EDITORIAL NOTES.

THE performance of the 10-wheeled Lake Shore locomotive on the recent fast run from Erie to Buffalo disposes of the last doubt as to the safety of this type of locomotive for fast runs, and also has shown that a very large wheel is not an absolute necessity. When we compare this engine with the English engines used on the Aberdeen run, all of which had larger drivers and larger cylinders, there is every reason to be well satisfied with the performance of the American engine; and on the same day after this remarkable run the locomotive took her regular train West out of Buffalo without going to the shop for the recaulking of flues or other repairs.

THE difficulty that is experienced by the Navy in securing competent officers for the engineering department has been well known for a long time, and a recent movement having for its purpose the securing of suitable engineer officers is full of significance. Graduates of technical schools are to be invited to enter the navy, because of the reluctance of the graduates of Annapolis to enter the engine-room service. Graduates of Annapolis, who are thoroughly drilled to consider the line as the place for a gentleman and to look down upon their brothers of the engine-room as greasy mechanics, who have no rights that the officers of the line are bound to respect, naturally prefer the deck to the stokehold. It is barely possible, however, that if the department would shake off the conservatism that seems to enwrap it, and place the engineer officer on a par with the officer of the line, the difficulty of inducing the graduates of Annapolis to enter the engineering service would be to a great extent overcome; but so long as the present state of affairs exists, it is natural that only those who have a taste for mechanics should elect to become an engineer. Surely the men who have charge of the maintenance and operation of such tremendous complications of machinery as our present battleships embody deserve the fullest recognition, and it seems to partake somewhat of the nature of a bunco game to attempt to induce the graduates of technical schools to enter a service wherein their whole previous training has been of such a nature as to render them totally incapable of comprehending the conditions that will surround them.

CAR VENTILATION.

IN these days of superabundance of literature, probably the rising and the latest-risen generation know little or nothing of the old-fashioned almanacs in which our grand and great-grandparents placed so much confidence. In pessimistic moods we are apt to think that this is the age of humbug; but what modern fraud can equal the editor or publisher of the old almanacs, who, six or more months before the beginning of a year, assumed the gift of prophecy, and undertook to foretell not only what the weather would be for 365 days thereafter, but also threw in in addition thereto a number of miscellaneous predictions concerning a variety of other events. We old chaps remember the rude wood-cuts on each page representing the sower, the reaper, the shearer of sheep, etc., which were supposed to represent the occupations of the farmer in the respective months to which the engravings formed a sort of vignette. On the margin, or in the form of notes, the author would venture his predictions to the effect that about this time the reader should look out for storms, for heat or for cold, earthquakes, pestilence, influenza, or other diversions, which formed the bases for the comedies and the tragedies which afforded the real diversions of our ancestors.

If a railroad almanac were constructed on somewhat the same principles, the vignette for November would appropriately be a picture of a snow-plough, with the maxim, "In time of peace, prepare for war," paraphrased into, "*In the Indian summer, prepare for snow-storms;*" and in the marginal note the prediction, "About this time look out for editorials on car ventilation." Certain occupations, duties, and diversions, such as the sowing of seed, heating of cars, and flying kites, are suggested by the vicissitudes of the seasons. It is so with the homilies on ventilation. In the marginal reading of the railroad almanac for the month of November might also be added, "About this season foul air and bad smells may be expected in railroad cars." When that occurs, then is the time for the railroad editor to get in his article on ventilation. That time is now.

To those of us who have been writing such articles for the past quarter of a century or more, the contemplation of this duty suggests the query whether, instead of writing another one, it might not be better to prepare a sort of an outline, analogous to what is called a skeleton sermon, for the use of our younger brethren, who, if they continue in editorial work, will frequently have occasion to write such articles, especially if they travel much and are gifted with an acute sense of smell.

In its general treatment the subject might be divided into two parts:

I. The importance of pure air and good ventilation, and the evil and disagreeable effects of vitiated air.

II. The means to be employed or how to secure good ventilation.

These two divisions of the subject might then be discussed under the following headings:

1. The hygienic importance of fresh air. (Under this heading almost any book on physiology or hygiene may be consulted, and ample evidence and material can be obtained to show the wholesomeness of fresh air and the deleterious effects of impure air.)

2. Definition: What is "ventilation"? (In the article under that title—"Ventilation"—in the *Encyclopædia Britannica*, it is said that "ventilation is the process of changing the air of rooms and other closed places so that a certain standard of purity may be preserved, notwithstanding the vitiation which

the air undergoes from the breath of inhabitants, the products of combustion of illuminating agents, and other causes." Amplifications which may be made on this text are obvious.)

3. The impurities with which the air of inhabited rooms is vitiated. (The most ready index of these impurities, it is said, is the amount of carbonic acid contained in the air. This, however, is not the only test of vitiation, and not even the most dangerous impurity. The amount of oxidizable organic matter it contains is another index; but perhaps the most dangerous impurity is the micro-organisms, especially bacteria, contained in the air of badly ventilated rooms. It is said that an habitually close room becomes a sort of nursery of those dangerous occupants. This branch of the subject may lead out in many directions. Some one has said that a knowledge of modern bacteriological science made him feel as though he was an old cheese, infested with maggots. If one of the purposes of such an article as is here outlined is to make railroad travellers feel uncomfortable, there is ample opportunity for dilating on the unspeakable filth which is breathed in an ordinary car, and a great variety of horrible diseases might be described which may be caught there through the insatiable energy for colonization possessed by these aggressive bacteria.)

4. The standard of purity which should be maintained in the air of a car or room. (This will probably be somewhat analogous to our standard of morality, to which some of us try in a more or less ineffective way to conform as closely as we can, but always find ourselves very far from our criterion. Ordinary out-door air is assumed to have about four parts of carbonic acid to 10,000. It is assumed, too, by some authorities on ventilation, that air should not under any circumstances contain more than 10 parts in 10,000. To maintain this degree of purity requires that 1,000 cub. ft. of fresh air should be supplied to each person per hour. Other authorities say that the supply should be *at least* from 3 cub. ft. to 4 cub. ft. for each person per minute, or from 180 to 240 per hour—a wide difference from the first quantity named. An obvious inference, therefore, is that the greater the amount of fresh air which is admitted, the better will be the ventilation. The most perfect ventilation is out-of-doors, where the supply is unlimited. The doctrine may, therefore, be inculcated that it is well to admit as much fresh air as possible into cars consistent with the comfort of passengers.)

5. How to determine the amount of carbonic acid and micro-organisms of a car. (The chemists have devised various methods for ascertaining the quantity of this deleterious gas in the atmosphere, and it is said "the micro-organisms may be caught by slowly passing a given volume of the air to be examined through a tube coated inside with beef jelly; the germs are deposited on the nutrient jelly, and each becomes in a few days the centre of a very visible colony." Happily for us, it is said that these organisms do not increase very rapidly unless they have time and a suitable medium to breed in. It would be interesting if some bacteriologist would take samples of old plush from car seats which has been absorbing carbonic acid and been colonized by bacteria for a decade or longer, and ascertain what kind of population occupy its territory. We know that the *cimex lectularius* and *pediculus vestimenti* are often found there, and probably minuter organisms also find lodgment in its texture, and possibly in great numbers. These are suggestive topics, and if properly worked up might add greatly to the existing apprehensions and terrors of railroad travel.)

The second division of the subject would fall under the following heading: How to ventilate a car.

Here the writer would do well to again refer to the encyclopædia article from which quotations have been made. The author of it says that "in order that the atmosphere of a room should be changed by means of air currents, three things are necessary:

"(*a*) *An inlet or inlets for the air.*

"(*b*) *An outlet or outlets, and*

"(*c*) *A motive force to produce and maintain the current.*"

Owing to their importance, they have been italicized. The writer goes on to say of them, "that one might think it needless to enumerate such obvious requirements were it not that, in providing appliances which are intended to act as ventilators, one or other of these essentials is not infrequently overlooked." This seems to be especially true of car ventilation. It is singular too what curious superstitions are believed in with reference to ventilation. One of these is the delusion that to ventilate an apartment of any kind, all that is needed is to make an opening of some kind at the top, and that the air will then very obligingly proceed to flow out of that aperture. Ordinarily it will do nothing of the kind. If the reader has ever undertaken to drive a drove of pigs which have broken into a corn field out through a gap in the fence he will find that they are inclined to go everywhere else excepting through such an outlet. In his efforts to surround the pigs and drive them out, he may learn a lesson in ventilation. Air, like the pigs, is averse to escape unless it is forced to do so. As a matter of fact, we are living at the bottom of a great ocean of air. We might get a clearer idea of the condition of things if we would imagine that we were all mermen or mermaids, and that the bottom of the ocean was our dwelling place, and that railroads and railroad cars existed there, and that we all breathed water instead of air, somewhat as the fishes do. It will be imagined, further, that in some aquatic train a car was occupied by 60 voyagers, and that the water in it became vitiated. What folly it would be to expect that if a number of openings were made in the top of the car, that the water in it would immediately flow out! It would be impossible for it to do this unless some other water was admitted to take the place of that which escaped. If the car were not water-tight, or if its doors or windows were opened, some fresh water might thus enter, and a corresponding quantity of that in the car might escape; but the supply of fresh water would thus be in a great measure accidental, irregular, and uncertain. To have a constant supply, provision would have to be made for that which is impure to escape, and *also* for the admission of an equal supply of fresh water. Besides this, the water in the car, like all other inanimate matter, would be inert. It would have no disposition to move unless compelled to. A motive force would be required to move it. This might be supplied by the buoyancy produced by warming the water, or from currents produced by the movement of the train, or from mechanical means, such as a pump. Exactly analogous conditions exist at the surface of the earth. These are at the bottom of the great ocean of air. To change that in a car, provision must be made for a quantity of bad air to escape and an equal quantity—enough to keep that which is breathed reasonably pure—to enter, and some *sufficient* motive force must be supplied to cause the air to move. It will not do it of its own volition, or because we may want it to do so. Adequate INLETS, OUTLETS, and MOTIVE FORCE are three absolute essentials to produce good ventilation. Unless we have all of them it will be impossible.

In a rapidly moving railroad train there is little difficulty in providing the two last, and, quite curiously, it is these which have received most attention, and on which there has been the greatest amount of ingenuity and thought exercised. It is as though a person should devote his time and attention to devising ways and motives for spending money, and make no effort to supply an income. That has been tried very often, and has never succeeded. The difficult problem in ventilation, then, is how to admit an adequate supply of fresh air to a car.

There is little or no trouble in exhausting or getting the bad air out of a car. If a back door or back window is opened it will escape fast enough, if only an equal amount is admitted

somewhere else. The great difficulty is that the incoming air in winter causes discomfort because it is cold, and in summer because it is mingled with dust and cinders. The problem of car ventilation, then, really resolves itself into the question of how to admit enough fresh air without causing discomfort to the inmates. Those for whom this article is intended are, therefore, advised to consider ways and means for doing this. The exhaust, as has been said, will give little trouble. Since the introduction of the asphyctic vestibules the uncertain supply which formerly entered through the open doors and ventilators in the ends of the cars is denied to the passengers. The vestibules form a sort of tunnel which conducts the vitiated air from the front end of the train to the back, and thus the carbonic acid and other exhalations from the bodies of passengers, with the dreadful micro-organisms of various kinds, are carefully kept inside the cars instead of being allowed to escape. In a recent railroad journey a drawing-room car, of which the writer was an occupant, was placed immediately behind a dining car, the kitchen of which was at the back end, and the two were united by a vestibule. The consequence was that "we" and our fellow-passengers were inhaling the atmosphere of a scullery during the whole journey of 143 miles.

We venture the prediction that the time is not far off when the owners of railroads and most managers will have a realizing sense that vestibules are an expensive humbug. They are not only costly, but they are heavy, they obstruct ventilation and ingress and egress to and from cars. The only thing which they accomplish which may not be done by much simpler and cheaper means is that they prevent dudes and dudettes from soiling their gloves in passing from one car to another. When they are used, the admission of air at the end of the car—the most advantageous point for its entrance—is impracticable, or, at least, difficult.

Of the admission of air, the writer of the article which has been quoted from says:

"With regard to inlets, a first care must be to avoid such currents of cold air as will give the disagreeable and dangerous sensation of draft. At ordinary temperatures a current of outer air to which the body is exposed will be felt as a draft if its velocity exceeds 2 ft., or at most 3 ft. per second. The current entering a room may, however, be allowed to move with a speed much greater than this without causing discomfort, provided its direction keeps it from striking directly on the persons of the inmates. To secure this, it should enter, not horizontally nor through gratings on the floor, but vertically through openings high enough to carry the entering stream into the upper atmosphere of the room, where it will mix as completely as possible with warm air before its presence can be felt. A favorite form of inlet is that shown in the engraving. When opened it forms a wedge-shaped projection into the room, and admits air in an upward stream through the open top."

That this method of admitting air is very effective in producing good ventilation can be shown experimentally in any cars heated with stoves and provided with slatted blinds at the windows. If the end window in front of the stove and the corresponding one at the back end of the car are raised 6 in. or 8 in., and the blinds are lowered, the movement of the car will cause a current of air to flow inward at the forward end, and it will be deflected upward by the slats in the blind, and as it enters the car it will be mingled with the ascending currents of hot air around the stove, and it will thus be delivered into the car at a comfortable temperature, and in a current above the heads of the passengers. At the same time, there will be an outward current drawn from the window at the back end, through which the vitiated air will escape. The warm air from the stove at this end, it is true, will be drawn out of the car, which would, of course, be objectionable in very cold weather. A car may, however, be throughly well ventilated in this way.

The objection to this method of ventilation is that more or less smoke and dust are carried into the car through the window. For this reason ventilators were long ago placed above the end windows, in which position they are under the projecting roofs over the platforms and are protected from cinders, and, being higher up than the windows, less dust is admitted when they are in that position. Slatted registers have also been used in such ventilators.

Sliding windows in the doors of cars are also much used, especially in sleeping cars, and are an excellent means of cooling off a car when it is too hot; but they produce disagreeable drafts, especially in cold weather. End ventilators in clearstories are also much used, and usually have a door or wicket, which is hung on what may be called trunnions, placed on a horizontal centre line transversely to the car. The air which enters under this door is not directed upward, but falls on the heads of the passengers near the front end of the car; and as mankind have a wholesome dread of cold drafts, as soon as such currents are felt the ventilator is apt to be closed. Besides this defect, such ventilators are often made too large; and thus, when they are opened in cold weather, too great a volume of air is admitted and the dreaded drafts are felt, and it becomes difficult to keep the car warm. By making the inlets to such ventilators in the under side of the projecting roofs over the platforms, and protecting them with fine wire netting, some dust and many cinders will be excluded.

The best possible arrangement for the admission of air to a car would seem to be a ventilator somewhat like the one shown in the illustration, and having an area of about a square foot of area, and placed in the end of the clearstory, with an inlet in the roof over the platform and protected with wire netting. This arrangement is, however, impracticable when vestibules are used; but if that useless luxury is insisted upon, doubtless the inlets could be placed in some other locality, where they could be supplied with fresh air from out-of-doors.

As an accessory to the care and use, and as a permanent instruction to the public and to the railroad employés of the purpose and objects for which such ventilators are intended, they should each have inscribed on them in letters easily legible from any part of the inside of the car:

IF YOU WANT TO BREATHE PURE AIR, KEEP THIS VENTILATOR OPEN.

There is a chance for some enterprising manufacturer of car furnishings to make a comfortable profit by making ventilators of this kind, and placing them in the market. But whoever makes them, he should keep in mind that the inscription is important for its educational effect. It is a rather remarkable fact that a comparatively small proportion of the

public seem to know that a ventilator is needed to admit fresh air. Their only conception of the function of such appliances is that they are intended for the escape of air when the car is too hot. Most railroad employés and many officers hold the same opinions.

The purpose of our article is to impress upon those who are responsible for the ventilation of cars, that the essential thing for them to aim at is to provide means for the admission of as much fresh air into cars as possible, consistent with the comfort of passengers. There is not the least danger of getting too much in, provided the passengers are kept comfortable. The more the better.

As a specific recommendation, it is believed that a form of inlet ventilator, somewhat like our illustration, will be the most effective, and if not absolutely the cheapest, it will certainly cost very little. The inscription, which is considered very essential to its effectiveness, will cost nothing after the patterns are made. It is not patented, and the only expense which railroad companies might reasonably object to is our hoped-for commission for the suggestion and the design.

NEW PUBLICATIONS.

THE SAFETY VALVE has been purchased by *The Coal Trade Journal*, and the office removed to the Times Building, New York.

POOR'S MANUAL OF THE RAILROAD OF THE UNITED STATES.—This annual publication comes with the certainty of fate and the regularity of taxes. It contains this year 1,412 pages of text, or 20 pages more than last year. It is, of course, the same immense storehouse of statistics and data among railroads that it has always been, and is simply indispensable to those who have business with railroad companies.

LE VOL SAUTÉ (LEAPING FLIGHT). By Edmond Alix. In French. Paris: G. Masson. 135 pp., 51 figures, 6¼ × 10 in. 6 francs.

We have here a new theory of flight by Dr. Alix, who published in 1874 an elaborate essay upon the locomotive apparatus of birds. In the present volume he follows this up by a full description of the physical structure of three birds: the swift, the swallow, and the goatsucker; and, having passed in review their general characteristics, he gives in great detail their osteology or framework and their myology or arrangement of muscles. These descriptions take up the first 112 pages of the book, when, having described the machinery, the author advances a new theory as to its action, referring more particularly to the termination of the downward wing stroke. He says:

"By a rapid, almost instantaneous movement, while the hand (outer end of the wing), through its spread primary feathers, obtains a bearing on the air, the forearm is abruptly extended against the hand, while the arm is extended against the forearm.

"There results a pressure against the shoulder, which generally obtains upward, inward and forward. This pressure, through the medium of the shoulder bones, drives all the body of the bird.

"In this movement the bird leaps upon his wings; and as we conceive this to be the true mechanism of flight, we have termed it 'leaping flight,' as distinguished from other conceptions, and more particularly from that termed 'rowing flight.'

"At the moment of the leap the wing is not folded; it is already more or less extended and spread out, but not entirely. In leaping, the wing fully completes its extension—it is a sinuous surface which abruptly straightens out.

"The wing's leap is so rapid that it escapes observation; it is *the real effective movement which is not seen, and which explains the results of the apparent flap, which alone is visible.*

"It is an intrinsic movement of the wing which sometimes coincides with apparent immobility, and sometimes is concealed in the general movement.

"It is not, therefore, by beating the air with his wings that the bird flies, but by spreading his wings and leaping thereon when fully spread out. It is through this leap that the bird darts forward like an arrow."

Then the author describes in detail the working of the mechanism in effecting these results, and calculates the muscular force which must be expended. He comes to the conclusion that the tension upon the motor muscles is but little more than the weight of the bird; that the power required for mere support is not great, and that it is not much greater at normal speed.

All this may or may not be true. It seems difficult to prove or to disprove the existence of a movement which the author himself says cannot be distinguished, although he shows it to be anatomically possible; but it is interesting to compare this theory with the old one of rowing flight, and of the final "whip lash" action which is supposed to confer forward propulsion.

TRADE CATALOGUES.

[IN 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes. They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

STANDARDS.

For postal-card circulars	3¾ in. × 6¾ in.
Pamphlets and trade catalogues	3½ in. × 6 in. 6 in. × 9 in. 9 in. × 12 in.
Specifications and letter-paper	8¼ in. × 10¾ in.

THE number of specimens of this kind of literature has accumulated on our hands to such an extent that it makes it necessary to condense our notices into less space than we have heretofore ordinarily given to such reviews.

"THE BOYS" HAVE SOMETHING TO SAY ABOUT DIXON'S PURE FLAKE GRAPHITE. Joseph Dixon Crucible Company, Jersey City, N. J. 16 pp., 5½ × 6¾ in. [Not standard size.]

This company recently sent out samples of their graphite to locomotive engineers for trial, and have published in the pages before us the reports of their experience in its use, and the results.

SURFACE GRINDING AND POLISHING MACHINERY. Diamond Machine Company, Providence, R. I. 8 pp., 6 × 9 in. [Standard size.]

The publishers here describe a number of machines which they make for grinding and polishing. The illustrations are excellent wood-cuts, and the descriptions are full and clear. They report increasing business.

THE CORRESPONDENCE SCHOOL OF TECHNOLOGY, Cleveland, O. 60 pp., 6 × 9 in. [Standard size.]

This school has been organized for instruction in engineering through the mail, similar to the Scranton School. The courses and methods of study are fully described and explained, which is the purpose of the publication. The offer of a special commission to students who obtain other students does not, however, produce a good impression.

THE ELECTRIC STORAGE BATTERY COMPANY. Sole Manufacturers of the "Chloride Accumulator" Drexel Building, Philadelphia, and 66 Broadway, New York. 52 pp., 6 × 8½ in. [Not standard size.]

The purpose of this pamphlet is to describe the chloride accumulator, which is also illustrated, but with rather a poor quality of engravings. The description, however, is very full, and will interest all who are concerned in electric matters.

W. D. FORBES & Co, Engineers and Manufacturers, Hoboken, N. J.

This firm have issued a descriptive catalogue of 20 pp., 6 × 9 in. [standard size], in which the high-speed automatic engine, yacht engine, milling machine, revolution counter, hydraulic hand pumps, and the national chucks, all of which they manufacture, are illustrated and described.

CATALOGUE OF THE GISHOLT MACHINE COMPANY, Madison, Wis. 44 pp., 6 × 9¼ in. [Not standard size.]

The specialties which this company make are turret lathes and screw machines. A number of different patterns of these are described and illustrated by half-tone engravings. The latter half of the book is devoted to illustrations of different pieces and kinds of work which can advantageously be done on these machines, and to some descriptions of the methods of doing it.

J. A. FAY & Co., of Cincinnati, have issued a large placard about 2 × 3 ft., containing illustrations of their works and wood-working machinery, and which they request in red letters should be hung in a conspicuous place. Unfortunately wall space is too valuable in New York to permit us to comply with their request; but doubtless their customers, potential and actual, who have unlimited shop room, will take pleasure—and have profit, too—in complying with their instructions.

PRICE-LIST OF IMPROVED HYDRAULIC SCREW AND LEVER JACKS, ETC. Watson & Stillman, 204–210 East Forty-third Street, New York. 37 pp., 5¼ × 8 in. [Not standard size.]

The first statement made by this firm in their price-list is, "Cash in New York bankable funds," which is a good basis to begin on. This is followed by a description of their jacks and directions for using and repairing them. In the remaining pages engravings, descriptions and prices are given of the various kinds they make. Among the articles of their manufacture are also portable double screw hoists, and the Tonkin three-roller adjustable and single size expander, which they say "is the best in the world."

ILLUSTRATED "CATALOG" OF QUINT'S TURRET DRILLS. A. D. Quint, Hartford, Conn. 20 pp., 6 × 9 in. [Standard size.]

The machines described in this "catalog" are a vertical drill press, in which from two to 12 drill spindles are carried by a turret whose axis is horizontal. Each of these spindles has a bevelled pinion which is driven by a wheel in the turret on a horizontal shaft. They are so arranged that only the spindle and drill in use revolves. The illustrations are good wood-engravings, excepting the diagrams on page 11, which are process work, and are made on too small a scale to show clearly.

UNITED STATES METALLIC PACKING COMPANY'S PRICE-LIST. Philadelphia. 26 pp., 6 × 9 in. [Standard size.]

The publishers have given in this list blank specifications for their packing, intended, apparently, for ordering it; illustrations and prices of locomotives, stationary and marine engine and air-pump packing; McDonald's balanced valve; the Gollmar bell-ringer; Norris' lever lock mechanism; the McIntosh oil-cellar and oil-cup for engine truck and driving-axle boxes; Saylor's portable drilling, reaming and tapping machine; a valve-stem clamp for holding a valve if an engine should break down; and oil-cups of various kinds, all of which they make.

CATALOGUE OF AUTOMATIC CUT-OFF ENGINES, built by J. H. McEwen Manufacturing Company, Ridgway, Pa. Office, Havemeyer Building, New York. 30 pp., 5¾ × 9 in. [Not quite standard size.]

This company has given in their very neat catalogue illustrations of the interior of their shop, external views of their horizontal tandem compound, simple vertical, and horizontal engines. They have also an excellent sectional view of a horizontal simple engine, and various views of different parts and details showing their construction, with descriptions thereof. The book ends with tables giving powers and dimensions of their different engines.

MONOLITHIC SUBWAYS. Sewers, Electric Conduits, Drains, Cable and Electric Roads, Ditches, Water Pipes, Tunnels, etc. The Ransome System. Ransome Subway Company, Monadnock Block, Chicago. 24 pp., 6 × 9 in. [Standard size.]

In this pamphlet the method which has been patented by Mr. Ernest L. Ransome of making continuous or monolithic pipes and conduits of various kinds of concrete is described and illustrated, and the advantages of the system are explained. The illustrations do not deserve a very high degree of commendation, but perhaps they serve their purpose, which is all that can reasonably be demanded.

Mr. Ransome has devised a continuously moving and adjustable mould, around which concrete pipe is formed, the mould being of such a shape as to make all parts of the work accessible to the workman. The pipe is of course made in the position which it is intended to occupy, and is without joints.

Various reports and opinions on the merits of this method of construction are added in the form of appendices.

1895 CATALOGUES AND PRICE-LISTS OF MACHINERY, TOOL AND CASTINGS, STANDARD RULES, CAST-STEEL TRY-SQUARES, WIRE GAUGES, AND TOOLS FOR ACCURATE MEASUREMENTS 366 pp.

This is a new edition of a catalogue which is issued annually, and which contains a great deal of interesting and valuable information to practical machinists and those engaged in mechanical engineering work of any kind. The new volume contains about 60 pages of new matter, and describes many new tools and appliances which have recently been brought out by the publishers, and which will interest practical mechanics who take a pride in knowing all that is to be known about their occupations. The book will be found very useful for reference, as it contains data not easily accessible elsewhere, concerning gearing, tools of precision, cutters of various kinds, micrometre calipers, gauges, etc. Persons who aim at being supplied with the most approved appliances for doing work in the best way and at the lowest cost should have this catalogue within reach.

FROM the Frick Company, of Waynesboro, Pa., we have received the following catalogues:

CORLISS STEAM ENGINES. 114 pp.

HIGH-SPEED AUTOMATIC STEAM ENGINES DESCRIBED AND ILLUSTRATED. 56 pp.

REFRIGERATING AND ICE-MAKING MACHINERY. 216 pp.

These are all 6 × 9 in. [standard size], and are deserving of very high commendation, as they are about all that a trade catalogue should be. They are elaborately illustrated, with general views of the machines made by this company, which are either half-tone engravings or very excellent wood-cuts. Besides the general views there are detailed engravings showing the various parts of the machines, with excellent descriptions accompanying them. Those representing the valve gear of the Corliss engines may be particularly commended for fulness and clearness. Very good views of the interior of the shops are also given. Only an extended review of these publications would do them justice, and for that we have not room. We will take space, though, to say that the company are manufacturing: 1. Automatic high-speed slide-valve engines, both simple and compound, horizontal and vertical; 2. Corliss cut-off engines, also simple and compound, condensing and non-condensing, vertical and horizontal; 3. Refrigerating and ice-making machinery for all kinds of purposes. It would be manifestly improper for us to say that any one wanting such machinery could not do better than to get it from the Frick Company; but we will say that persons who contemplate getting engines or refrigerating machines will be without a very valuable source of information if they have not examined the Frick Company's catalogues before they decide where to place their contracts.

CAR-BUYERS' HELPER. How a Good Car Differs from a Poor One, and how to Get it. Brownell Car Company, St. Louis. 172 pp., 6 × 9 in. [Standard size.]

The sub-title of this book might leave the reader in a little doubt whether the author intended to indicate how to get a good car or a poor one, were it not for the fact that the Brownell Company are not supposed to build poor cars.

In the preface it is said that the book "has been made to give the reader a sufficient knowledge of electric and cable cars to enable him to negotiate for them advantageously."

With this object in view, engravings are given in the first chapter of the framing or skeleton of a car, and also the panelling. The construction of these, and also the strains to which they are subjected, are then explained. The next chapter contains a series of illustrations showing the details of the joints, trussing, panelling, roof, platforms, etc., with descriptions of how they should and how they should not be made.

The third chapter is on the Cheapening of Cars, and discusses the material used in their construction, the method of making panels, glue and glueing, "scrims," etc. Chapter IV is largely devoted to painting and varnishing, bolts, bronze for trimmings, seats, plush, carpet, glass, and "everything else." Street-car Builders are also discussed in a separate chapter, which is followed by another on Specifications, and a sort of skeleton for proper specifications is given. Then there are observations on Getting Bids, Inspecting, First Class and Cheating Car-Builders, etc. In a chapter near the end, the "Accelerator Car," which was designed for the Broadway Road, in New York, is described and illustrated, and, apparently, it is to this chapter that all the previous ones lead up. The advantages of this car are very fully set forth, and a very funny horizontal sectional plan is given, showing a car of this kind crowded with people. The observer is supposed to be looking down on the heads of the passengers. Various other views of these cars are given, and their advantages are fully set forth. The last chapter is devoted to Mr. F. B. Brownell, the author of the book and the president of the car company, and gives his history.

The style of this production might be called boisterous, and reminds one of the Mississippi River taken at full flood, on

whose banks the writer of it dwells. His little brochure is, however, full of valuable suggestions, and is one of the very few good books on car-building in existence.

COAL HANDLING FOR STEAM GENERATION. C. W. Hunt Company, 45 Broadway, New York. 52 pp., 6¾ × 9¼ in. [Not standard size.]

Although it is not said so specifically, it is intimated on the first page of this catalogue that with the machinery which is described in it coal has been taken from the hold of a vessel which came at irregular times, stored it in a 6,000-ton pocket 800 ft. distant, then took it from the pocket and delivered it continuously, day and night, to the front of boilers for a cost, including the interest on the investment, of less than 3½ cents per ton, and that the reduction of the cost of handling 25,000 tons of coal per annum by this means was from 27½ cents to the figures named, which represented a net profit of $6000 per annum. The catalogue is devoted to the description of machinery required for doing this kind of work, which is a specialty manufactured by the C. W. Hunt Company. The general character and purposes of these appliances for handling coal is indicated in a description of the plant furnished to the Edison Electric Illuminating Company of Brooklyn. The work to be done at this station, it is said, "was to take the coal from the wagons, carry it to storage bins above the boilers, weigh it, deliver it to the furnaces, and to remove and dispose of the ashes. The coal is carried from the hopper underneath the sidewalk to the coal tanks above the boilers by a conveyer which, upon its return, passes under the furnaces and carries the ashes to a storage bin, from which they can be drawn into carts at will. The conveyer used to do this work consists of a series of gravity buckets pivoted in a double chain, and the whole system is carried on self-lubricating wheels in the manner shown in the illustrations."

Besides the plant referred to, the general arrangement and appliances used in other locations are illustrated and described. Among them are those at the Brooklyn Water Works; the Brooklyn Heights Railroad Company; the Fifty-second Street Railway Station; the Metropolitan Street Railway Company, in New York; the Edison Electric Illuminating Company, in Boston; the Baltimore City and Suburban Railway Company; the Detroit Citizens' Railway; the United Electric Light and Power Company, of New York; the Philadelphia & Reading Terminal Company, of Philadelphia; the Brooklyn Elevated Railroad Company; the Manhattan Elevated Railroad Company, and one for the Boston & Maine Railroad Company. These are illustrated by views made from photographs and sectional and other engravings, which show in some cases the general arrangement of the plant, and in others the details of special parts and appliances. The descriptive matter is very satisfactory, and altogether the catalogue is an interesting one, which those having charge of the handling of coal will find very useful.

HIGH PRESSURE STEAM. The Babcock & Wilcox Company, 29 Cortlandt Street, New York. 38 pp., 7¼ × 10⅜ in. [Not standard size.]

What is in reality the introductory text of this volume is the statement that in 1875 the pressures carried on the best class of stationary plants did not average over 65 lbs., in 1880 about 90 lbs., in 1890 about 125 lbs., and to-day pressures ranging from 185 lbs. to 250 lbs. are not uncommon where the highest economy is required, driving compound, triple and quadruple-expansion engines.

That high pressure has come to stay is assumed by the publishers of the catalogue under review, an assumption which probably will not be questioned. Brief descriptions and illustrations are then given of the boilers exhibited at the Centennial Exhibition in Philadelphia in 1876. In all there were 11 sectional and three "shell" boilers exhibited. Of these it is shown that the three shell boilers—fitted to carry low pressures—have survived in the same form, and that only the Babcock & Wilcox, of all the sectional boilers, is still made of the same design, although the Root boiler has been but slightly changed. At the Chicago Exhibition in 1893 not a single shell boiler, it is said, was exhibited under steam. The conclusion which it is intended should be drawn therefrom is that if high pressures are to be employed, sectional boilers must be used. It is said that "for high pressures, boilers with shells of large diameter, whether internally or externally fired, are no longer admissible. Their deterioration under heavy strains is too rapid to warrant the danger of running them."

In this connection the fact that all of the three shell boilers exhibited in Philadelphia have survived, in substantially the same form, to the present time, while of 11 sectional boilers only two have survived, cannot be ignored. Then, too, it is said that "for many years the pressures carried on locomotives in this country greatly exceeded those carried on stationary plants. It started at about 100 lbs., rose to 120 lbs. in 1860, to 150 lbs. in 1880, and at the present time as high as 180 lbs. pressure is carried on compound locomotives." These high pressures have uniformly been generated in shell boilers, with a considerable portion stayed.

The conclusions inculcated in the publication under review are that boilers must be made to carry high pressures, not only temporarily, but for a long term of years, and that the sectional form of boiler is the only one which will do this safely. Such boilers should be made so that they can be cleaned and inspected from the outside, and the units of which they are composed can be removed and replaced. Cast metal, it is said, is uncertain, and should not be used in the construction of boilers.

To indicate the character of the work which they do, the Babcock & Wilcox Company have appended a copy of a complete blank specification under which their boilers are manufactured. Numerous views of their works and also engravings showing details of construction of their boilers are given.

The engravings, paper, printing and general designs are all of the best, and are from the press of Bartlett & Co.

NOTES AND NEWS.

South African Exhibition.—There is to be an International Exhibition of the South African Republic at Johannesburg during the months of May and June, 1896, which offers to American manufacturers a good opportunity for making their products known in that far-off but rapidly growing country. It will open on May 1, and remain open during that month and June, and will be conducted under the auspices of the International Exhibition Company and the patronage of His Honor, S. J. P. Kruger, State President, South African Republic. The Company may be addressed by mail or telegraph at Johannesburg.

Car Ventilation.—At the meeting of the American Public Health Association, which was held in Denver in the early part of October, Professor S. H. Woodbridge, of the Massachusetts Institute of Technology, read a paper on Car Ventilation, in which he stated the requirements to be as follows:

"The air must be furnished by other than natural means so called. The supply rate must be as little as possible affected by the movements of the coaches or the wind; the air must be continuously and regularly supplied in generous quantity, the action of the system being plenum rather than vacuum, in order to reduce the inward leakage of cold air, smoke, dust, and cinders. The heat should be generated at the floor, and evenly distributed and well regulated. The air should be entered warmly and cleaned, and in such a manner as to reach effectively all occupied parts of the car. To avoid disturbing wind or air pressure effects, either a velocity must be given to the air entering from the outside highly in excess of that which the average maximum pressure would produce, or the inlet pressure must be automatically regulated with reference to pressure, so as to insure convenience of flow. A high efficiency fan would be requisite—one that would have 1,800 revolutions per minute and be 18 in. in diameter. It would be run in a chamber especially designed for free-air movement, and would run with avoidance of noise if moved by a ¼-H.P. rotary steam motor, taking its supply from the steam beneath the cars and passing its exhaust either into the heating system or outward. The fan might be run (though at more cost) by an electric motor, the electricity for the dynamo coming from a belt connected with the axle-wheel.

"A suitable filter to cleanse the air of smoke and dust and readily movable for cleansing could be made. Such a filter would consist of a box of square 40 ft., made of fine wire gauze and fibrous material such as cotton wool, placed back of the wire netting.

"To introduce air into a coach without danger of annoying local drafts, and to adapt the method to sleeper, parlor, and day coaches alike, one or more overhead channels through which the air could be delivered laterally to one-half of the car could be made practicable. The monitor roof construction would furnish ready accommodation for such an arrangement. The air-density at 65° would cause it to settle downward with moderate action, and the location of inlet and outlet could be chosen so as to cause the air once delivered into the car to take up a movement toward the other end from that at which it was supplied. At the other extremity it should be given a free ceiling discharge. If desired the supply could be given a floor delivery by substituting for the guards which now cover the steam pipes boxes about two-thirds of a square foot free area, each one of the boxes opening beneath the seats for the delivery of air. But this would not be so desirable."

If this plan were carried out it seems as though it might be

necessary to appoint a graduate from the Institute of Technology or some other similar school to travel with each train to superintend its ventilation. It was said at the same meeting that the Wagner Palace Car Company had opened a special school where its employés are instructed in the proper cleaning and ventilation of cars, which is good news, as some of them need instruction—or rather knowledge—on these subjects very much. We are disposed to believe that the removal of the modern vestibules from trains would do as much for ventilation as anything else. They exclude a great part of the small amount of fresh air which passengers were formerly permitted to breathe. The vitiated air from the front end of the train now passes through to the back end, and the more that is allowed to escape from the rear cars, the greater the amount which is drawn into them to take the place of that which is exhausted. The paramount question in all systems of ventilation is where and how an adequate quantity of fresh air is to be supplied. If enough pure air is admitted, there will be no trouble in allowing that which it should displace to escape.

Test of Armor and Ship.—The Naval Ordnance Board conducted a most important and successful test at Indian Head proving grounds on September 4. Primarily it was a test of steel armor plate, but really of greater importance. It was a trial of the strength of the frames of modern warships, which it had been claimed would not withstand the shock caused by heavy projectiles against the armor covering them, some authorities even going so far as to assert that the armor, if not shattered or penetrated by the shot, would be driven through the vessel by the crushing of the frames. This was the first frame test ever made of distinctly modern warships, though the English Government some years ago did fire at an antiquated armored vessel for the purpose of observing the effects of the shot.

The experiments demonstrated the fact that the frames of our warships are perfectly able to meet all ordinary demands. It was also demonstrated that the new 14-in. armor with which the new battleships will be protected can, under ordinary conditions, receive the fire of any vessel afloat without serious damage. A test was also made of a new armor bolt designed by the Ordnance Board to replace the bolts now used in fastening armor to the ships, which are weighty, cumbersome, and expensive. Each of the three tests was entirely satisfactory. The armor plate far exceeded the prescribed requirements, the counterfeit frames bore the shocks without impairment, and the bolts were entirely satisfactory.

The plate tested represented 24 others, weighing 620 tons, made by the Carnegie Company for the battleship *Iowa*, now building at Cramps'. It was the first service test of the company's new process of making what is known as double-forged armor, being forged both before and after carbonization or Harveyizing. Heretofore it has not been forged after being Harveyized. This plate, 14 in. in thickness, formed the outer surface of a target, which was an exact reproduction of a side section of the battleship *Iowa*. It was 18 ft. long by 7½ ft. high, and represented that portion covering the vitals, and extending 5 ft. below and 2½ ft. above the water-line. Behind the armor was a backing of 5 in. of oak, and then came the "skin" of the vessel—the inner and outer bottoms, each five-eighths of an inch of steel plate. Some 4 ft. further back was a ⅝-in. steel plate, representing the inner shell of the vessel. Between this plate and the "skin" were the frames or braces, also of ⅝-in. plate, alternately 2 and 4 ft. apart. The whole structure was covered by a 2½-in. steel plate, representing a protective deck. Against the inner plate were heavy timbers resting on the side of a hill.

It would seem at a glance that the conditions were not the same as on board a ship in the water for the reason that the water would yield, while the solid earth would not. But the naval officers calculated that this difference would be very light, as the vessel in the water could not yield quickly enough to be of any benefit.

The first shot fired was from a 10-in. gun, a Carpenter projectile weighing 500 lbs. being propelled by 140 lbs. of brown prismatic powder, and attaining a velocity of 1,472 ft. per second, and a striking power of 741,000 foot-pounds. The shell was completely shattered by the impact, only the point being imbedded in the plate, which was not otherwise injured. So loose was the point in the plate that it fell out entirely from the concussion caused by the third shot. The backing and frames were found intact.

As this shot had made scarcely any impression, the charge of powder was increased on the second shot to 216 lbs., giving the 500 lbs. projectile a velocity of 1,862 ft. per second. As before the shell was shattered, a larger portion, however, being imbedded in the plate, which was still without a crack or bulge. One of the armor bolts was driven out, the thread being sheared off; but this was expected to happen when a bolt is struck by a shot. Several of the small bolts holding the protective deck were broken, but this was not considered material, for the reason that the bolts were used as a makeshift, a metal joint being the usual method employed. This completed the acceptance test for the lot of the 24 plates, and they will undoubtedly be approved.

Then one shot was fired from a 12-in. gun. A Wheeler sterling projectile, weighing 850 lbs., was urged along by 400 lbs. of powder at a velocity of 1,800 ft. per second. This test was ordinarily employed on 17-in. plates, and it was thought that it would pass entirely through the 14 in. of steel, and the backing, frames, etc., as well. While the plate was penetrated almost its entire depth, and cracked from top to bottom, the oak backing was scarcely disturbed, and the outer skin and the frames were not disturbed at all. Another armor bolt was forced out, and the rest of the bolts in the protective deck were snapped off. So this plate not only stood the test for its own thickness, but constructively for a 17-in. plate.

The new armor is less than half the length of the bolt now in use, and the saving in weight in each ship will be considerable. In addition, the packing used with the old bolts is quite an item, as a brass cylinder, a spring washer, and rubber rings are necessary, whereas in the new ones ordinarily tow packing, with a lead washer, suffices. The test was made under the direction of Captain Sampson, Chief of the Bureau of Ordnance, and was witnessed by Secretary of the Navy Herbert and the Board of Ordnance. A further test, this time with a 13-in. gun, will be made as soon as the gun can be set up.—*New York Sun.*

Guns of the British Battleship "Majestic."—The *Majestic* is the first large ironclad which has been built since the *Royal Sovereign* class, and yet, with the exception of the Hotchkiss guns, there is not a single gun or mounting on board the *Majestic* that does not show some marked improvement on those of her immediate predecessors. The *Majestic* is armed with four 12-in. Woolwich wire guns, in barbettes; twelve 6-in. Elswick quick-firing (wire) guns, four on the upper deck and eight between decks; sixteen 12-pdr. Elswick quick-firing guns, and twelve 3-pdr. Hotchkiss quick-firing guns, on Elswick recoil mountings. Interest naturally centres on the 12-in wire guns and their mountings. The guns themselves are of Woolwich design and manufacture, but before their design was approved of the representatives from the leading firms of gun-makers were called in and asked to criticise. As the design was put into execution it may be presumed that it was considered satisfactory. It embodies a very full development of the wire or ribbon construction, no less than 102 miles of wire being wound on each gun. The wire is rectangular in section, and it is wound on with an average tension of 40 tons to the square inch. Jackets of steel are put on the gun outside the wire, so that as far as external appearance is concerned they do not differ from an ordinary steel gun. The breech mechanisms of the 12-in. guns have been designed with a special view to rapidity and ease of manipulation. The only fault that can be found with them is that they are somewhat complicated, but, as one man can open the breech in about six seconds, even after firing proof charges, a little complication is excusable.

The method of securing the guns to their cradles—and now we pass from Woolwich to Elswick designs—is quite new. Instead of the broad bands passing over and strapping the gun on their cradles—as in the *Royal Sovereign* class and previous ships—"thrust rings" are provided to the 12-in. guns which fit into corresponding grooves in the cradles and thus transmit the longitudinal thrust of recoil. Slots in the rings and keys keep the guns down in their places. The arrangement actually in use for securing the guns to their cradles are thus all below the axis of the guns, and are well protected. There is another new feature about this method of attachment. It will easily be understood that for convenience the breech screws of guns in a turret or gun-house have to work to opposite hands, the breech screw of the right-hand gun hinging on the right-hand side of the gun and the breech screw of the left-hand gun on the left-hand side. At first sight it appears that to effect this the guns themselves would have to be right and left-handed, a system which would cause, and has hitherto caused, a liberal and costly supply of spare guns. But the Elswick plans get over this by arranging that the guns shall be reversible. If it is required to place the right-hand gun in a left-hand position, it is only necessary to turn it upside down. The "thrust rings" encircle the gun and therefore always coincide with the grooves in the cradle, and slots are provided in the rings to meet the requirements of either position. Each gun with its complete mounting is made to balance (when the gun

is out in the firing position) upon a pair of trunnions. These trunnions are fitted to the slides and are strong enough to transmit the shock of recoil to the structure of the turntable, as well as to take the whole weight of the gun and mounting. The object of the balancing is to make it possible to give elevation or depression to the gun by hand, and still retain recoil in the line of fire. The guns may be run in or out by hydraulic pressure. In firing, it is only the notion of running out that is necessary, for the recoil will always bring the guns in; but for cleaning purposes and drill it is convenient at any time to have the power of running them in. Hitherto guns in the Navy worked by hydraulic power have been loaded in the "run in" position, but the *Majestic's* guns are loaded when run out. Much more room is thus obtained in rear of the guns for the loading operations. In the *Royal Sovereign* class there is but the one fixed loading position—that is to say, after each round the turntable has to be brought to a certain fixed position and locked there until the operation is over. If one gun only has been fired, the other has to be practically put out of action for about two minutes until the first has been reloaded. In the *Majestic*, however, in addition to the fixed ammunition hoist, which has been retained with the idea that to load both guns simultaneously it is the quickest system, there is a central or all-round loading hoist for the supply of the powder, and a considerable stock of projectiles stowed in the gun-house provides the other essential. Thus either gun, or both guns, can be loaded in any position, and the loading of one gun does not in any way interfere with the working or firing of the other. To sum up, every operation can be performed by hand, should the hydraulic gear—which is, however, almost completely duplicated—break down. The guns can be loaded simultaneously at a fixed position or separately at an all-round position, and the time necessary for working the guns has been much reduced. As to the barbettes, the name is somewhat a misnomer, for the guns have a shield or house covering them which can hardly be distinguished from a turret—indeed, the advocates for the two rival systems of barbette and turret seem, in the *Majestic*, to have agreed to a compromise. The sloping sides and roof of the gun-house offer no surface to a direct hit from a projectile. The plating is 10 in. in front.

During a recent trial it is said the guns and the hydraulic gear worked to perfection and with the greatest smoothness. There was not the least hitch anywhere. All the guns were fired with cordite, and the ordnance officers seemed to be very favorably impressed with the new explosive.—*London Times.*

Electric Cable Railway up the Stanserhorn.—The inclined road up the Stanserhorn is the last which has been built in Switzerland, and presents in its general dimensions and special arrangements some points of considerable interest. The Stanserhorn is a mountain whose summit is 6,234 ft. above the level of the sea—that is to say, at a height intermediate between its two neighbors, Pilatus, 5,965 ft., and Rigi, 5,905 ft. This mountain rises above Stanserhorn, the chief town of the canton of Negii, and from which summit is seen the magnificence of the Bernese Alps, the Lake of the Toncan, and the mountainous regions of the northwest of Switzerland. The means of access are very easy. Steamboats run from Lucerne to Stanserhorn, where an electric tramway takes one in 15 minutes to the Stanserhorn Hotel, the point of departure of the tramway which is the subject of this note. This tramway is a trolley line run by electricity furnished by the same motive power as the cable line. The latter was opened in August, 1893. The difference in level to be traversed being 1,850 — 450 = 1,400, and the length about 13,124 ft., would have been too great for a single cable railway even though the contour might be all right which utilized at certain points the bed of a torrent, and which necessarily required repeated and constant curving. Therefore, the line is divided into three successive cable lines involving the trans-shipment of passengers at two intermediary points. The first section lies from Slais to Ketio, and has a difference of level in 714 — 450 = 264 metres. The length traversed on a horizontal line is 5,099 ft., but by following the grade, which is 5,085 ft., the inclination varies from 12 to ¼. The second section runs from Ketio to Blumett, the difference between the two points being 2,313 ft., with a length of 315 ft. on a horizontal line and 3,576 ft. on the grade. The grades are necessarily steeper, and vary from 40 to 60 per cent.

The third section starts from Blumett at an altitude of 4,006 ft. and runs to the hotel of Stanserhorn, 6,070 ft., making a rise of the section 2,064 ft. with a length of 4,183 ft. on the grade and 3,642 ft. on a horizontal line. The grades vary in the preceding case from 40 to 60 per cent. It includes several prominent structures of considerable importance, one a tunnel of 460 ft. in length, and a viaduct of the same length. From the hotel of the Stanserhorn a guide shows the way in a few moments to the summit of the mountain, which is located about 600 ft. away. Each section is composed of a single track with a passing point at the centre of its length. Each has two cars attached to the ends of a cable which passes over a truck driven by a dynamo. This installation is placed at the upper section of each station—that is to say, at Ketio and Blumett and at the summit.

The dynamos take their current from their water-power station and a water-power and electric station located at Boochs, 3 miles distant, where a fall of the Aa drives the turbines. In addition to the water-wheels there is a supplementary steam engine of 60 H.P. for driving dynamos in case there should be any interruption. The car bodies are in staircase form, and they are divided into four compartments for eight persons each, with the same number upon the platform; they can thus carry 40 passengers. The most original peculiarity of the Stanserhorn railway is the entire absence of the racks. The brakes act, not upon a tooth wheel, but directly upon the rails. They are formed by powerful apparatus which grips the rail under action of the right and left-hand screw; this screw is driven by a wheel which by an ingenious arrangement is driven by the wheels of the car, which slacken off on the tension of the cable and fits in contact with a friction wheel. It is a combination of the Croix-Rouss and Heberlein brake. The rails have a special contour so that the jaws can act upon them. They are the Vignole type. At first sight the absence of the rack on grades of 60 per cent. would seem slightly rash, nevertheless many severe tests have been made by the technical inspectors of the department of railways, and have shown that there is every confidence to be placed in this system. There are two pairs of ties, each of which can exercise a pressure of 29,772 lbs. The second pair driven on the platform acts as a hand brake. It cannot be doubted but that doing away with the rack, which always costs at least 20 francs per metre, will very considerably reduce the expense of construction. Experience will show whether this saving is not met by more or less serious disadvantages. The two tracks come nearly parallel to each other at the two intermediate stations, so that passengers have only a few steps to take to go from one car to another. And this is done under cover; the time used for running each section is the same, so that trains arrive at stations together. The speeds, therefore, are not the same; thus, upon one section the cars run 394 ft. a minute, and on the other only 279 ft. Each run occupies 13 minutes, so that with the time necessary for the transferring of passengers 45 minutes are required for the whole run. The vertical rise is therefore 10,935 ft. per minute, and the speed of transportation along the grade varies from 46 ft. to 39 ft. 5 in. per second—3 to 4½ miles per hour. This is a very slow speed; but it should be remarked that if this difference in level was traversed in shorter time by an ordinary railway, it would require a grade of 3 per cent. running 37½ miles per hour; and on a grade of 6 per cent. the limited adhesion would cut the speed down to 18.64 miles per hour. It is possible, therefore, to go from Lucerne to the Stanserhorn hotel in one hour and a half. There are 10 trains each day. The passage is $1.52 for the round trip by the cable line. A similar calculation to the preceding would make it 1 cent per mile for equivalent distance over a railway with 3 per cent. grades. This line was built by Bucher & Durer, who had already built the one on the Burgenstach, which is also an electric traction road, but running to a lesser height. Upon this latter there is a rack line on the Abt system.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST-PIPES AND SMOKE-STACKS.*

By Inspector Troske.

It is well known that the efficiency of a locomotive depends more upon the steaming qualities of its boiler than it does upon the proper dimensions being given to its principal parts and the adhesive weight that may be upon its wheels, and that this steaming quality is, in turn, dependent upon the combustion taking place upon the grate, and that this is finally dependent upon the strength of the draft. If this latter is too weak, the fire burns sluggishly and the steam production is low; while, on the other hand, if it is too strong there will be many pieces of unburned coal drawn through the flues, which will accumulate in the smoke-box as cinders, oftentimes even blocking up that space, or a portion will be thrown out of the stack as sparks; either case serving to increase the coal consumption unnecessarily. The draft may even be so violent, as a result of improper dimensions being given to the

* Paper read before the German Society of Mechanical Engineers.

exhaust-pipe and the smoke stack, that in many locomotives it will be found that the fire no longer rests quietly upon the grates, but dances up and down upon them; which not only has the evil effect of increasing the consumption of coal by a very appreciable amount, but admits more cold air through the air spaces into the fire-box than is actually needed for maintaining combustion. This excess of air lowers the temperature in the fire box and the tubes, and as a consequence injures the production of steam. By contracting or enlarging the mouth of the exhaust-pipe, we know that we can easily increase or weaken the draft, but there are well-defined limits in both of these directions. Contraction goes hand in hand with an injurious back pressure upon the piston, resulting in just so much work lost by the locomotive; while an increase in the diameter of the pipe causes a lessening of the vacuum in the smoke-box and fire-box, so that finally the equalizing reserve action of the exhaust disappears, and the four exhausts for each revolution of the driving-wheels are always sharply defined from each other, the steam, instead, as is the case when running at high speeds, of approaching continuity, now issues from the stack under separate impulses, and thus no longer acts uniformly upon the fire, but in a jerky manner. These are, therefore, the outlying limits to good and economical consumption of coal.

Furthermore, we are dependent, not only upon the proper size of the exhaust nozzle, but also upon its position below the bottom of the stack opening, and upon the dimensions of the stack itself—that is, upon its diameter, height, and position. These four dimensions have no less influence upon the action of the fire and the generation of steam than the exhaust nozzle itself. As with the exhaust nozzle, so by enlarging or diminishing the size of the stack, the draft may be lessened or increased, also by shortening or lengthening the same, and finally by raising or lowering the exhaust nozzle with reference to the stack.

I.—HISTORICAL SKETCH.

Soon after the construction of the first railway, experiments were instituted for the purpose of locating the exhaust nozzle in the most efficient position, and it is well known that Stephenson owes his victory in the locomotive contest at Rainhill, in 1829, to the fact that he was the first to make an application of the exhaust nozzles to boilers for inducing a greater draft. Pambour, in 1836, was the first to institute a systematic series of experiments. He made, however, only a few, and the results that he obtained are of no great value. Nevertheless Pambour set forth the proposition that the exhaust-pipe pressure varies directly as the speed of the piston and the generation of steam per hour, and, therefore, inversely to the sectional area of the pipe itself. He considered that the pressure in the exhaust-pipe was the same as the back pressure upon the pistons, until, in 1847, it was proven by Gouin and Le Chatelier that this is not the case. Among the French engineers who busied himself with this question at that time was Polonceau. He made some special experiments with exhaust nozzles of various sizes.

Clark first threw light on these subtle relationships by means of his very important and thorough investigations which were made in 1850. They were made upon a large number of locomotives, and from them the following results were obtained:

1. The vacuum in the smoke-box stands in direct relationship to the pressure in the exhaust-pipe. That is, the vacuum expressed in inches of a water column gives the pressure in the exhaust-pipe in inches of mercury:

$$\frac{\text{Vacuum in smoke-box}}{\text{pressure in exhaust-pipe}} = \frac{1}{13.6}$$

or, in round numbers, $\frac{1}{14}$.

2. The draft creating properties of the exhaust is, first of all, dependent upon the form and size of the stack and the position of the nozzle. Above does the height of the exhaust opening and the diameter of the stack influence this matter.

3. With each stack there is some maximum size of exhaust nozzle that will produce the best results. For a given boiler there is only one diameter of stack that is most efficient; and for all other diameters the nozzle must be contracted.

4. The best position for the exhaust nozzle is that from which the steam will be blown vertically into the stack. Hence the centre line of the nozzle must coincide exactly with that of the stack.

5. The products of combustion must be able to enter the stack easily, either by making the bottom bell-shaped, or, better still, by locating the exhaust opening below the top of the smoke-box by about the diameter of the stack.

The exhaust will thus be always blown through and through the products of combustion, and not merely over the top of the same. A straight, vertical exhaust-pipe is therefore greatly to be preferred to the crooked pipe that was formerly in general use, since it offers less resistance to the steam as well as to the gases in their passage to the stack.

6. The proper sectional area of the exhaust nozzle is dependent upon the grate area, the sectional area of the tubes, the diameter of the stack, and the size of the smoke-box.

The larger the grate area and the sectional area of the tubes in the fire-box tube-sheet, and the smaller the diameter of the stack and the size of the smoke-box, the larger it is possible to make the nozzle.

7. In order that a stack may work at its maximum efficiency, it must have a length that is approximately about four times its diameter.

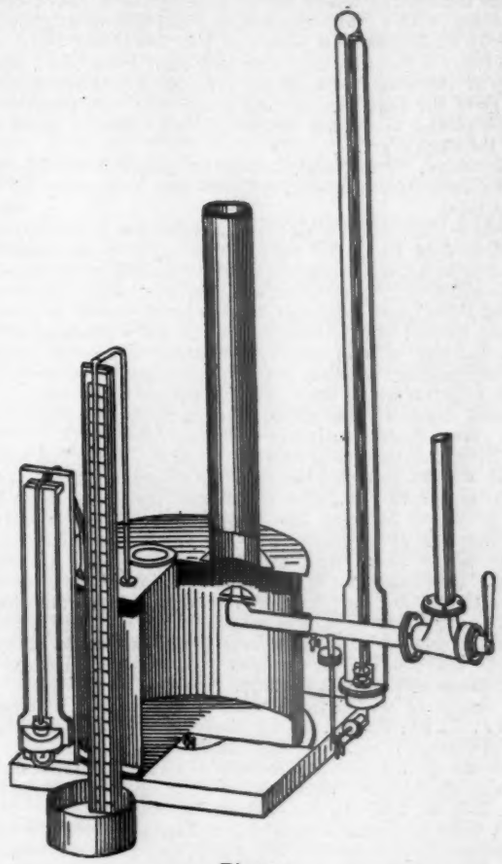


Fig. 1.

THE ZEUNER APPARATUS.

8. The smallest sectional area of stack that was observed was one-fifteenth of the grate area, and this permitted the use of a larger exhaust nozzle than any other larger stack. So that these observations are taken to indicate that this proportion (one-fifteenth) is the most efficient.

9. The exhaust nozzle may have a sectional area equal to from one-sixty-sixth to one-ninetieth of the grate area, provided that the sectional area of the tubes in the fire-box tube-sheet shall be made from one-fifth to one-tenth of the grate area.

10. The vacuum in the fire-box is from one-third to one-half of that in the smoke-box.

It should be remarked just here that the English locomotives of those days had very small grates, whose area did not average more than 12 sq. ft.; hence, Rules 9 and 10 cannot be applied to locomotives of the present day. Also, Rule 3 and the second paragraph of Rule 6, in which it is stated that the exhaust nozzle can be enlarged as the diameter of the stack is made smaller, cannot be applied in its general construction to locomotives. According to the Hanover experiments, the vacuum can be increased by making the diameter of the stack less. With this, if the original vacuum is to be retained, the nozzle may be enlarged, which will result in the lowering of the pressure in the exhaust-pipe and the back pressure upon the piston; but, as I stated at the opening of this paper, this enlargement of the nozzle must take place between narrow limits, else the combustion will be poor and the coal consumption increased. For this reason, then, it would be inexpedient

to use that small size of stack that would permit the largest nozzle to be used.

Furthermore, my investigations have led me to the belief that it is generally desirable to use as large a stack as possible. Especially worthy of note in the Clark rules that are given above are the results 2 and 5, wherein it is asserted that the height of the nozzle has an important influence upon the action of the fire, a position that is disputed as being incorrect by some later writers. Later, during Peacock's experiments, Clark was Locomotive Superintendent of the Manchester, Sheffield & Lincolnshire Railway, and in the summer of 1850 undertook a series of experiments with locomotives, and found that by lowering the opening of the exhaust-pipe and enlarging the same he could secure a better production of steam.

In the locomotive under consideration, which had a cylindrical stack with a diameter of 18 in., and having originally a nozzle 4¼ in. in diameter that was 1 in. above the top of the smoke-box; it was gradually dropped until it was 18 in. below the top of the smoke-box, where a nozzle with an opening of 4¼ in. gave the best results. As a result of this experiment Peacock placed all of his nozzles at this distance below the top of the smoke-box.

In Germany, Switzerland, and other countries these results seem to have been followed without any change up to the present time.

Zeuner.—Eight years after these experiments, in the summer of 1858, Zeuner began his well-known experiments upon the exhaust-pipe, which he continued during the following year, and in 1863 published his epoch-making book, "The Locomotive Exhaust-Pipe," and embraced therein his theory of its action.

Zeuner carried on his experiments in the workshops of the Zurich Railway with an especial apparatus. In order to render a comparison possible between the results obtained by various experimenters, who have made use of special apparatus, and determine the value of their deductions, it will be well to give a short description of them.

The Zeuner apparatus is shown in fig. 1. It consists essentially of a sheet-iron chamber having a diameter of 22.44 in. and a height of 17.7 in., into which the steam-pipe from the boiler projected carrying the blast nozzle at its extremity. Upon the top of this chamber the stack was placed and through it the steam with the air that had been drawn in escaped. Afterward an opening about 4 in. in diameter was made in the top for the purpose of admitting air. The steam pressure in the blast-pipe was regulated by means of a hand-cock and measured by a quicksilver gauge, while the vacuum that was induced in the chamber was also measured by a similar gauge and a water column.

The stacks, of which there were five, had clear diameters of 1.6 in., 3.2 in., 3.9 in., 4.7 in., and 5.8 in., while the blast-pipe had diameters of .39 in. and .56 in.

In the air opening for the purpose of changing its sectional area there were placed rings having clear openings of .39 in., .78 in., 1.56 in., 2.36 in., and 3.15 in. inside diameter.

From these investigations, which embraced over 2,000 measured observations with this apparatus, and from his theoretical opinions, which were the first upon this subject that were examined in so thorough a manner, Zeuner came to the following conclusions:

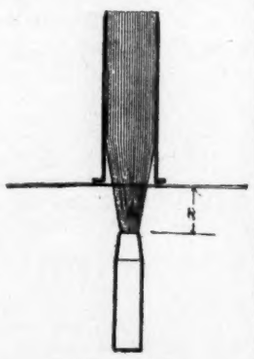


Fig. 2.

1. The distance x, as given in fig. 2, which is the distance of the top of the nozzle from the bottom of the stack, can be varied between tolerably wide limits, without particularly disturbing the evenness of the ratio of the vacuum existing in the chamber during the outflow of steam.

Nevertheless, adopted as the result of his investigations 1.57 in. as being the distance equal to x, at which the stream of steam could enter the different stacks with the least hindrance.

2. In general the opening of the blast-pipe must be raised and brought nearer to the mouth of the stack, as the latter is made smaller, provided the vacuum is to be kept the same. It may be possible to take the distance of the opening of the blast-pipe below the opening into the stack as equal to from one to two times the diameter of the stack that is being used.

3. In general it happens, in consequence of the friction of the steam and air in the stack, there is a marked diminution of the suction action of the stream of steam, if the length of the pipe is more than 30 times the diameter.

4. It was also observed that the position of the blast-pipe relatively to the opening into the stack, the capacity, and, in a general way, the very shape of the smoke-box of a locomotive, and, finally, the height of the stack, have all a very important influence upon the action of the exhaust. At least it may be asserted that locomotives built to-day in accordance with these directions can hardly be improved.

5. The vacuum—that is, the difference existing between the pressure in the chamber and that of the atmosphere—increases in a direct ratio with the steam pressure. It does not depend upon the absolute size of the steam opening, the air opening, and the stack, but upon the ratio existing between the first and the last, and the quotient:

$$\frac{\text{Area of steam opening}}{\text{Sectional area of stack.}}$$

6. For a given size of blast-pipe and air opening, there is always some diameter of stack, wherein the sucking action of the steam current is the greatest, and with all other diameters this action is weaker. This point of maximum efficiency leaves one in a position to define the theory of the action very sharply.

7. With the same nozzle opening and stack, the amount of air drawn in varies directly with the square root of the steam pressure.

8. The ratio existing between the vacuum in the smoke-box and the pressure in the exhaust-pipe is variable, and, with the ordinary blast-pipe arrangements, depends essentially upon the cross-section of the blast-pipe opening and a known coefficient u, indicating the resistance of the products of combustion in the tubes. If, therefore, we adopt the common acceptation of the results of Clark's experiments which have been used up to the present time, this ratio becomes one-fourteenth for locomotives, and that only an approximation and applicable, also, only to the locomotives upon which Clark conducted his investigations. On the whole, however, it appears that, when everything has been taken into consideration, this ratio can be subjected to no very great fall, provided the heating and running of the locomotive is normal.

It must be remarked just here, however, that the conclusions announced in Nos. 1, 3, 4, and 6 are not in accord with the results of the experiments carried out in the Leinhausen shops in the years from 1892 to 1894. In opposition to Zeuner, it must be said that the position of the exhaust nozzle relatively to the bottom of the stack, as well as the length of the stack, certainly does have an influence upon the working of the draft. Further, this is evidently not limited to a stack having a length equal to 30 times the diameter, but to one with a length of six diameters. Finally, that diameter of stack which showed the highest vacuum in the apparatus cannot be said to be universally the most efficient, since upon a locomotive it might act very unfavorably. We can see from the data developed by the Hanover experiments that the vacuum rises, the other conditions remaining the same as the stack is made smaller—that is, within certain defined limits, and beyond these limits it falls rapidly away. This stack, which in the apparatus gave the best draft, is too small for a locomotive, the ratio between whose grate and tube areas is based upon the dimensions of the experimental apparatus, and, consequently, would not give a proper draft to the fire nor an economical coal consumption, and so cannot be claimed to be the most economical. This brings up still another influence that will be referred to later.

That Zeuner reached the other results which he has promulgated depended upon his choice of the dimensions of his apparatus. Not only was the stack altogether too long, but it was far too large in comparison with the diameter of the blast nozzle that was used. The latter had, as we have already said, a diameter of only from .39 in. to .56 in., while the former was 1.6 in., 3.2 in., 3.9 in., 4.7 in., and 5.8 in. Hence, the diameters of these stacks were 4, 8, 10, 12, and 15 times as large as the .39 in. blast nozzle.

Now in actual locomotive practice, as well as in the recommendations of Zeuner we have nozzles varying in diameter from 3.5 in. to 5 in. Suppose we take one with a diameter of 4 in., we must, in accordance with the data given by this apparatus, have five stacks with diameters of 16 in., 32 in., 40 in., 48 in., and 60 in., sizes which naturally are wholly out of the question for practical work. Then, too, the smallest stack of the Zeuner apparatus gave values that varied from those obtained from the other four large ones, yet Zeuner disregarded it in his investigations, although it approached more nearly than any of the others to locomotive practice; and, in addition, the vacuum was very low, giving a water column of only 1⅛ in. with an excess of blast-pipe pressure of ¼ atmosphere, while in actual locomotive service it is at least double

this, with a blast-pipe pressure that is considerably lower. It is also highly probable that in the further stack experiments air was drawn in from above, as was shown to be the case in the Hanover experiments. From this point of view, also, Zeuner found a very slight difference in the vacuum, whether he conducted his experiments in an open or perfectly tight chamber, and from the same standpoint he found no marked influence due to the length of the stack, although he gradually shortened it from an original length of 4 ft. 11 in. to 14½ in. What an important influence this variation in length does have upon the action of the exhaust is evidenced by the Hanover experiments. Although it should happen that not one of the values derived from these experiments should have a practical working value, we still have the service which the genius of Zeuner rendered in developing the theory of the blast-pipe, and for which the painstaking investigations which he carried out were necessary.

Nozo and Geoffroy.—At almost the same time with Zeuner—that is, in the fall of 1860—the French engineers Nozo and Geoffroy carried out some similar experiments, independently of Zeuner, but also with cylindrical stacks only, since up to that time no other shape was known. The apparatus used by them is illustrated in fig. 3. It was similar to the Zeuner apparatus, yet with this essential difference, that it was not cold air but the products of combustion of a locomotive which were drawn in, and that the boiler of the same supplied the steam for the experiments. The steam was led from the throttle into a special reservoir of 11.3 cub. ft. capacity, and in this, while each test was being carried out, a constant pressure was maintained, which could be accomplished by means of the throttle-valve and one on the reservoir opening into a

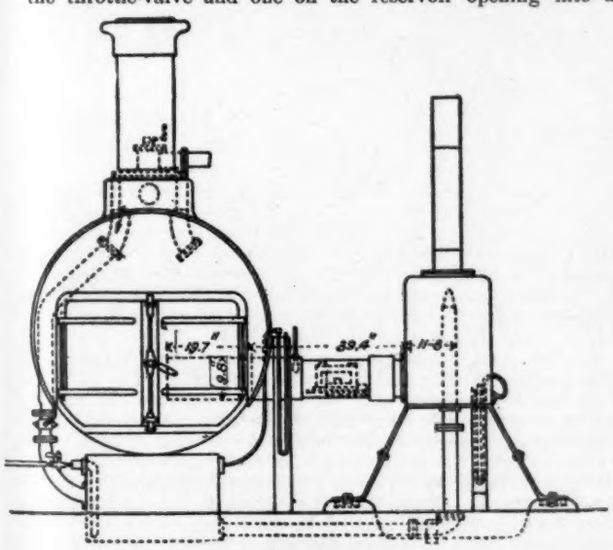


Fig. 3.
THE NOZO AND GEOFFROY APPARATUS.

waste pipe. The blast-pipe chamber also had a capacity of 11.3 cub. ft. In the pipe used for conducting the products of combustion into the chamber, an anemometer was placed which could be read through a glass-covered peep-hole. In order that the experiments might be carried on with openings for the admission of air of different sizes, false plates with holes of the same size, but varying in the number of the same, were placed in the blast chamber in front of the air-pipe. During these experiments the locomotive boiler was fitted with a stack 21 ft. 3½ in. high, whose natural draft sufficed for the generation of the steam.

The experiments were made with four blast-pipes of .39 in., .55 in., .79 in., and 1.1 in. diameter, and 10 stacks varying in diameter from 1½ in. to .79 in. in diameter. The height of the latter was equal to eight times its diameter. The perforated plates had a free sectional area through holes of .35 in. diameter that varied in number from 20 to 320. The steam pressure in the receiver varied from 1 to 11½ lbs. per square inch.

Upon using a blast nozzle having a diameter of 1.6 in., a stack 5.5 in. in diameter, and a steam pressure of 2 lbs. per square inch, a vacuum equivalent to a water column of 1.7 in. would be obtained in the smoke-box of the apparatus, while the temperature of the air that had been drawn in would be about 313° F. If the steam pressure was increased threefold to 6 lbs. per square inch, a vacuum of 5.55 in. would result, and the temperature would rise to 331° F., which was about one-half the true temperature. Nozo and Geoffroy arrived at the following conclusions:

1. Each length of stack that gives the maximum results is independent of both the area of the blast nozzle and the passage for gases, but not of the steam pressure, and is but slightly independent of the diameter of the stack. It must be from six to eight times that diameter. A greater length has no influence.

2. A funnel shaped opening to the bottom of the stack seems to have no marked influence upon the draft.

3. A stack of suitable length can project down into the smoke-box to the top row of tubes without injury to the draft, if the blast nozzle is dropped at the same time; but the draft is very seriously impaired if the lower end of the stack is plunged down into the stream of gases.

4. With a proper length of stack—that is, one varying from six to eight times the diameter—the distance of the nozzle from the stack has no marked influence so long as this distance does not exceed one and one half times the diameter of the stack; when this is exceeded the draft is materially injured. The projecting of the nozzle into the stack seems to have no detrimental influence worth mentioning, so long as the adjustment of the nozzle is such that it is in true alignment.

5. With a given sectional area of the tubes and nozzle, and a given velocity of flow of the steam, there will be one sectional area of stack that produces the greatest draft, the length being held at from six to eight times the diameter. In the neighborhood of this area the diameter of the stack can be subjected to considerable variation, without having any very great influence upon the amount of air that will be drawn in.

6. If with the same tube area or the same resistance the nozzle be changed from double to single, the result will be according to 5, that for a given stack and velocity of steam flow the draft will be increased.

7. An ordinary stack of a given section and a single nozzle can be replaced by a multiple stack and a multiple nozzle—that is to say, a single large nozzle can be replaced by a bundle of small tubes.

To these conclusions it may be remarked that the length of stack as they found it is too great, and is doubtless to be attributed to the small dimensions of the apparatus that was used. The ratio which corresponds to the effective action, as shown by the Hanover experiments, is that, for the maximum draft, the length should be from four to five times the diameter. Furthermore, the funnel-shaped opening does have a very important influence upon the draft, since it offers free access for the gases to the current of steam.

Likewise conclusions 3 and 4 do not coincide with locomotive experience, and the same may be said of the concluding portion of No. 5. As has already been noted, Zeuner says that a stack always maintains the best draft at a given ratio. Conclusion 6 is likewise at fault, for, for each diameter of nozzle there is also only one cylindrical stack that will give the maximum draft, provided the length remains unchanged, whose diameter increases the larger the nozzle that is used with the same steam pressure.

Conclusion 7 is of no practical value for locomotive work.

Nozo and Geoffroy also conducted their experiments upon a running locomotive while it was hauling a train. In this work they used seven different stacks having diameters of 9 in., 11 in., 12.5 in., 14 in., 15.4 in., 17.7 in., and 17.8 in., whose lengths were 6 ft. 2.8 in. The nozzle had a diameter of 4.3 in. with its opening 3.9 in. below the bottom of the stack, so that the effective height of the stack was 6 ft. 6.7 in. (2 metres).

The results obtained from these experiments were as follows:

The three stacks with diameters of 9 in, 11 in., and 17.8 in. were useless, while with the other four the trip could be readily made on schedule time. The stacks with diameters of 12.5 in., 14 in., and 15.4 in. diameter gave a plentiful supply of steam. A graphical result was drawn for each stack, and these showed that the diameter of 14 in. was the best for the locomotive under consideration.

Regarding these experiments, it may be said that the action of the stack appears to be judged entirely by the amount of draft obtained; but this construction is not the only one that should have an influence, for, in Germany at least, it is required of the stack that the fire shall not only work properly and burn quietly, but that the amount of coal that is carried from the fire-box to the smoke-box shall be as small as possible, thus cutting down the amount of sparks and cinders. It seems odd, too, to note in this report that with a stack of 17.7 in. diameter the trip was made in schedule time, while with a stack of 17.8 in. in diameter, or only .1 in. larger, the action was unsatisfactory. Here, at all events, there must have been some other circumstances at work which could not have been

known to the observers, so that the experiments of Nozo and Geoffroy are of little value for the construction and operation of locomotives of the present day.

(TO BE CONTINUED.)

HIGH-SPEED LOCOMOTIVE ON THE LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

SEVERAL years ago there was a lengthy discussion in one of the railroad papers on the possibility of a train being run from Chicago to New York in 18 hours, and many railroad men were, at that time, disposed to look upon the matter as impracticable if not impossible; but the high speeds for long runs that was first shown to be possible by the establishment of the Empire State Express in regular service after the 24-hour trains between New York and Chicago had been an accomplished fact, demonstrated that higher speeds than those to which we have been accustomed were a possibility for long runs. The Empire State Express, or the trains making the preliminary runs, held the record, we believe, until the recent race between the East and West Coast routes from London to Aberdeen transferred the record to the credit of the English roads. The possession of the record was of short duration, however, for a special train on the New York Central & Hudson River Railroad promptly wrested the prize from the English, only to lose it with equal promptness to the Lake Shore & Michigan Southern Railway in the run reported in our last issue, whereby a party, by taking advantage of the Empire State Express from Buffalo, made the passage from Chicago to New York in 17¾ hours, thus more than realizing the dreams of 10 years ago, and making this quick passage an accomplished fact.

That improvements in the road-bed and cars have contributed greatly to this achievement is beyond a question, but the main credit belongs of necessity to the locomotives. These machines are naturally of great interest, and we publish herewith a reproduction of a photograph of the engine making the fastest time over a division on the recent Lake Shore run. It is of the 10-wheeled type, and, by its performances, has demonstrated that the six-coupled engine is a reliable high-speed machine, and it will only remain to duplicate the trip, using a mogul, in order to wipe away the last prejudice against the pony truck for fast work.

The following is a list of some of the principal dimensions of this locomotive, which was built for the railroad company by the Brooks Locomotive Works, of Dunkirk, N. Y.:

GENERAL DESCRIPTION.

Gauge	4 ft. 8½ in.
Fuel	Bituminous coal.
Cylinders	17 in. diam.; 24 in. stroke.
Driving wheels	68 in. diameter.
Rigid driving-wheel base	8 ft. 6 in.
Total " "	15 ft.
" wheel base of engine	25 ft. 3 in.
" " " " and tender	48 ft. 8 in.
Weight of engine in working order	113,500 lbs.
" " " on engine truck	25,000 lbs.
" " " " drivers	88,500 lbs.
" " tender, loaded	78,000 lbs.

BOILER.

Type	Crown-bar wagon-top
Working pressure	180 lbs.
Material	Steel, ⅞ in., ½ in., 7/16 in.
Riveting	Longitudinal seams, quadruple lap, without welt.
"	Circumferential seams, double lap.
Waist diameter at smoke-box	52 in.
Tubes	202 in number, 2 in. diam. charcoal iron.
"	Length, 13 ft. 10 in.
Fire-box	96 in. × 42 in., inside ring.
" depth	64 in. at front end, 50 in. at back end.
" crown sheet	Arched 1½ in. laterally in centre.
Brick arch	Carried on three 3½ in. water tubes.
Heating surface, fire-box and arch pipes	145 sq. ft.
" " tubes	1,462 sq. ft.
" " total	1,603 sq. ft.
Grate area	28 sq. ft.
Tube opening	3.6 sq. ft.
Safety valves	1 Richardson muffled and 1 Richardson plain.
Extension front	Deflector in front of exhaust pipe.
Stack	Cast-iron straight 16 in. diam.
Exhaust pipe	High double.
Grates	Cast iron rocking bar.

MACHINERY.

Cylinders	17 in. × 24 in., 84 in. centres.
Cylinder packing	Dunbar
Valves	Brooks Locomotive Works, Allen Richardson.
" lap outside	1 in.
" " inside	3/16 in.
" lead in full gear	3/16 in.
Valve travel, maximum	6¼ in.
Driving-wheels, diameter	68 in.
" centres, diameter	62 in.
" tires, Midvale	With Mansell retaining rings.
Driving axles	Hammered iron.
" " journals	7½ in. × 9 in.
Engine truck, four-wheeled	Swivelling centre.
" " wheels	33 in. Allen paper.
Engine truck axles	Hammered iron.
" " journals	5 in. × 10 in.
Feed water	Two No. 8 Monitor injectors.
Brakes, train, and tender	Westinghouse.
" drivers	"
Train signal	"

TENDER.

Frame	10 in. Channel steel.
Tank	⅜ in. and ¼ in. steel.
" capacity, water	3,700 galls.
" " coal	6 tons.
Tender trucks	Diamond pattern.
" " bolster	Steel I beam.
" " wheels	36 in. Allen paper.
" " axle	Hammered iron.
" " " journal	4 in. × 7 in.

This locomotive hauled the train over the division extending from Erie to Buffalo, and, as reported in our last issue, it was here that the fastest time between Chicago and Buffalo was made, showing at one point a speed of 96 miles per hour. The following is a detailed schedule of the run by stations:

Miles.				Miles per Hour.
	Left Erie,	10.20 A.M.		
11	" Moorhead,	10.32 "		55
4	" North East,	10.35 "		80
4.8	" State Line,	10.38 "		96
10.7	" Westfield,	10.47 "		71.3
8.1	" Brocton,	10.52 "		97.2
9.1	" Dunkirk,	10.59 "		78
12.7	" Irving,	11.09 "		76.2
2.0	" Farnham,	11.10½ A.M.		80
4.1	" Angola,	11.14½ "		61.5
12.3	" Athol Springs,	11.25 "		70.2
7.2	" Buffalo Creek,	11.31 "		72
2	" Buffalo Depot,	11.34 "		40

86 miles to Buffalo Creek.
88 " " " Depot.

Average speed per hour, Cleveland, O., to Buffalo Creek, N. Y. 68.33 miles
" " " " Erie, Pa., to Buffalo Creek, N. Y. 72.67 "
" " " " " " " Dunkirk, N. Y. 73.4 "
Maximum speed, 96 miles per hour.

In connection with this engine, which is, we believe, the first 10-wheeler to make such exceedingly fast time, it will be interesting to make a comparison with the locomotives making the fast time on the recent London-Aberdeen race.

The Great Northern locomotive hauling the East Coast express over the first division of the line from London to Grantham had a single pair of drivers 8 ft. in diameter and cylinders 19½ in. in diameter, with a stroke of 28 in. The average time for the 105 miles was 55.8 miles per hour, with a speed of 62.5 miles for one stretch of 59 miles of the distance. These engines are similar in design to those used on the Royal Blue Line from Jersey City to Philadelphia. There is a four-wheeled bogie truck forward and a trailing two-wheeled truck back of the fire-box and rigid with the frame. The cylinders are outside the frame and the boiler in between the wheels, with its centre below the tops of the latter. Over the second division of the Great Northern, from Grantham to York, a similar engine was used, except that the drivers were 7 ft. 6 in. in diameter and the cylinders 18½ in. in diameter, with a piston stroke of 26 in. From York to Newcastle, on the Northeastern the train was still hauled by an engine with a single pair of drivers 7 ft. 6 in. in diameter, with cylinders 19 in. in diameter and 24 in. stroke of piston.

From Newcastle to Edinburgh the Northeastern engines were eight-wheeled (four wheels coupled) inside connected, with 7 ft. drivers and cylinders 19 in. in diameter and 26 in. stroke. A similar engine was used on the North British Line on the run from Edinburgh to Aberdeen, except that this engine had the smallest cylinders and drivers of any engine on the run. The former were 18 in. in diameter, with a piston stroke of 26 in., and the drivers were 6 ft. 6 in. in diameter. It will be seen, then, that this Lake Shore locomotive had smaller drivers than any of the English engines, as well as being smaller than the well-known No. 999 of the New York Central & Hudson River Railroad. Taking the highest rate of speed attained by this engine of 96 miles per hour, we find that the piston speed was 1900 ft. per minute. It shows, too, that the attainment of high speeds is not necessarily dependent upon the use of drivers of large diameters, though that may be a very desirable property for the locomotive to possess.

THE VENTILATION OF THE BOILER-ROOM.

ONE of the weak points of steam service at sea is the high temperature of what is known sometimes by the significant name of the "stoke hole." The exhausting character of the work there seems to be intensified by the progressive changes incident to the development of great ships and high motive power, and not only in tropical seas, but even on the North

Atlantic firemen have not infrequently become so affected by the heat as to throw themselves overboard, or attempt to do so, as happened a week or two since on one of the great liners of the weekly Atlantic service. In war vessels the heat of the fire-room is likely to become insupportable at precisely those times when it may endanger the safety of the ship or diminish her fighting powers. Commander McGiffin, to whom we owe so many valuable notes on the practical conditions of modern marine warfare, has pointed out the terrible condition of his firemen in the Yalu fight, when the temperature of the fire-room rose to such a point that men were blinded permanently by its effects.

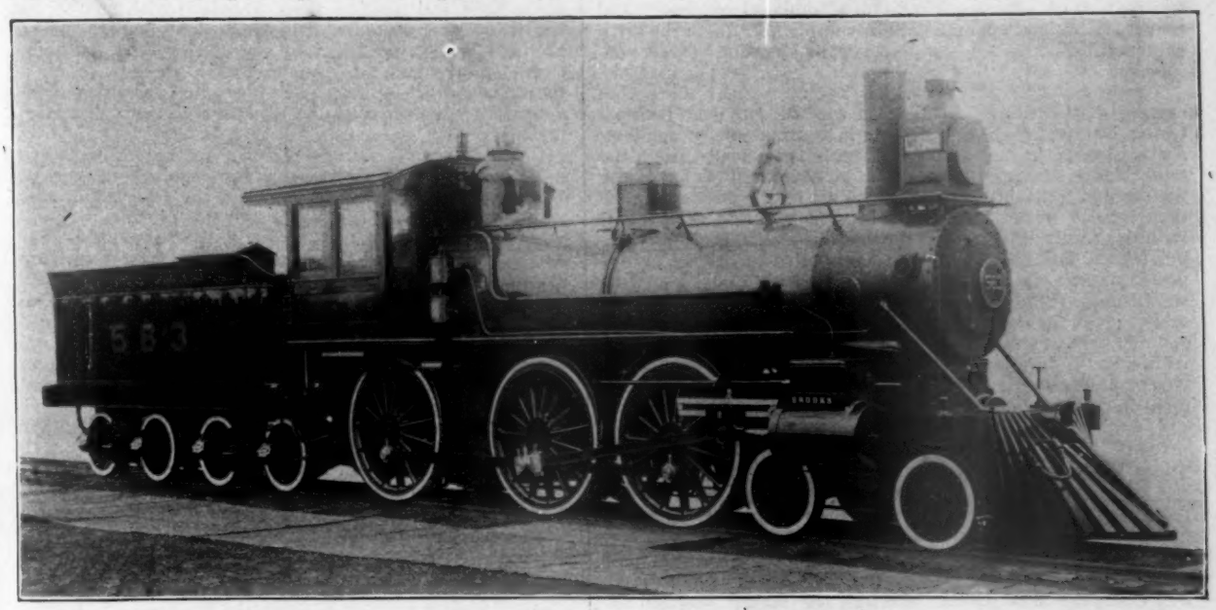
The importance of the subject has been recognized from the first, and devices for improving the condition of the firemen have been discussed most anxiously, but it is safe to say that no navy in the world has attained anything like efficiency in this important branch of the ship's hygiene. We shall not, therefore, be considered presumptuous if we point out that there is only one method by which the human frame can be made to support active labor in high heat, a method based upon the unchangeable laws of nature.

The fundamental principle which must underlie any successful device of this kind is that the body must be made its own refrigerator, and there is but one mode of applying this principle—a stream of comparatively dry air must be so directed upon the man's body that his perspiration will be vaporized rapidly and the refrigerating effects of evaporation produced. The body should be as nearly nude as the strong radiation from the furnace will permit, and the men should drink freely, preferably of cool barley water.

The change from the existing system which we propose is radical. At present the method of ventilation employed may be called the room method, as opposed to the method of individual refrigeration. A large quantity of air is thrown into the boiler-room with the intention of establishing there an atmosphere in which the men can work. It does not appear that the quality of this air has received much attention, though it is useless to bathe perspiring men in an atmosphere already loaded to the maximum with moisture. It is not only the method of ventilation that must be changed, but its uses, for the whole object of ventilation in the presence of great heat is to cool the man's skin and not his lungs, and for the former use cold air is not only useless, but detrimental. We have spoken of "comparatively dry air," and air is of this kind when it possesses the power of absorbing moisture. This power is a function of temperature, and may be given to moist air, like that of the ocean, by warming it and raising its capacity for humidity; but the present system fails entirely in this respect.

We think it will be found that the air thrown upon the firemen should have nearly the temperature which the fire-room naturally takes from the furnaces. One hundred degrees Fahrenheit is by no means an exhausting or even a difficult temperature to work in. Men by thousands have sustained that heat and much more than that in this country, not for short periods, but for eight hours a day, 28 days in the month, and year after year. We know of one instance where men were working in a temperature of 112° F. Air was taken from a point where the temperature was 88° and driven by a rudely made fan through a galvanized-iron pipe, in which its temperature rose to 108°, the pipe being so disposed that it pointed straight for the men who were working, stripped to the waist, about 15 ft. away. The fan must have had a very low efficiency, perhaps not more than 30 or 40 per cent.; but when the steam was turned on a little and the fan ran faster one of the men came back saying it was cold, and turned down the steam. In other cases of successful ventilation of working men the respective temperature of working place and air supply were 98° and 96°, 112° and 109°, 114° and 114°, 112° and 111°, and others much higher could be adduced.

These temperatures are comparable to those which obtain in steamer boiler-rooms under ordinary conditions; and it would be possible to show that the higher temperatures in tropical climates or under unfavorable conditions are not greater than those which have been met successfully on land. The follow-



TEN-WHEELED LOCOMOTIVE, BUILT BY THE BROOKS LOCOMOTIVE WORKS FOR HIGH-SPEED SERVICE ON THE LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

ing data from the French corvette *Ariadne* are old, but they are sufficiently representative. We give Fahrenheit reading:

Month.	Locality.	Temperature.		
		Engine-Room.	Boiler-Room.	Coal Bunkers.
October	German Ocean	79	136	..
"	Atlantic Ocean	98	125	....
"	Mediterranean Sea	104	138	...
November	Red Sea	122	153	104
"	Indian Ocean	109	147	....
"	Straits of Malacca	115	156	....
January	Manila	118	149	109
"	Chinese Sea	80	122	80
April	" "	105	115	86
July	" "	113	147	95
September	Red Sea	93	143	91
"	Port Said	100	154	86
"	Mediterranean	94	143	90
"	"	97	138	88

The difference between the coal bunkers and the boiler room varied from 39° to 68°, the latter being at Port Said, when the ship was probably at anchor. The ventilation was entirely by deck funnels. As to the readings recorded, it is doubtful if the observations can be accepted without question, as the thermometers may have been exposed to direct radiation from the furnaces or hung against heated walls. It is noticeable that the boiler-room was as hot in the German Ocean as in the Mediterranean and Chinese seas, and if its high temperature is dependent on artificial conditions, it can be controlled by artificial means. The readings given for the coal bunkers indicate that the temperature of the atmosphere was not too great, even in the Red Sea, for successful ventilation and refrigeration.

Starting from the premise that at sea the humidity ratio is high, the system of individual refrigeration would include three essential requirements, (1) air warmed in a close con-

duit where it receives no moisture; (2) projection of this air with its capacity for moisture thus raised directly upon the firemen; (3) the free use of water to produce perspiration, which by its prompt evaporation in the eagerly absorbing warm air current will cool the man's body according to well-known laws.

This system probably involves the use of artificial ventilation, but that is always present or provided for in ships of war, and always in use at critical periods, such as a fight. Whether it is possible to apply it to deck ventilation is a question that probably depends upon constructive details of each ship. That the current from the funnels can be warmed and thus improved in quality is probably true, and it is also true that this warming would increase the men's comfort instead of decreasing it.

These are questions of application with which engineers must grapple. Our part is done in pointing out that there is a scientific method by which the ventilation of boiler-rooms can be lifted out of its present condition of hideous inefficiency, and that it is a method which is certainly applicable under the critical conditions of battle. It deserves the attention of naval engineers.

The unscientific notions which have governed the action even of distinguished engneers on this subject may be illustrated by the following history: in cutting one of the long Swiss tunnels the men suffered severely from heat, throgh the temperature, about 80°, was not to be compared to that in the fire-room of a modern steamship. Two efforts were made for their relief. In the first cars of ice were run into the tunnel, with the result of increasing the discomfort of the men by the heightened humidity of the air. With this experience an opposite method was tried, and cars loaded with unslaked lime were run in, the object being to remove the objectionable humidity; but the heat produced was insupportable. In this country perfect success has been obtained and men enabled to work steadily in much higher temperatures by the simple device of preheating the air supply, and projecting it directly upon the men's bodies.—*Army and Navy Journal.*

THE BREAKAGE OF A LOCOMOTIVE DRIVING-AXLE ON THE GREAT NORTHERN RAILWAY OF ENGLAND.*

At eight o'clock on the morning of February 28, 1895, as a train of empty coaches belonging to the North London Railway Company was passing through the facing junction between the (Great Northern Railway) down slow and down Enfield lines at Woodgreen, the leading axle of the engine broke inside the boss of the right-hand wheel. The train did not leave the rails, but the right-hand corner of the engine frame struck the south end of the ramp of the down island platform, and sliding up it caused the engine to turn over on to its left side across the down goods and down Enfield lines.

Driver Charles Floyd and fireman Edward Cowland were both thrown under the engine when it fell over, and instantly crushed to death; and guard Patrick Delaney, who was in the front brake van, was thrown down in his van and bruised.

The train consisted of an eight-wheeled tank passenger engine, No. 109 (with leading bogie and four wheels coupled), and 12 coaches, including two brake vans, one at each end of the train. The engine, which was running bunker foremost at the time of the accident, weighed 49 tons 13 cwt., the weight being distributed as follows: on the bogie, 14 tons, 8 cwt.; on the driving-wheels, 18 tons; and on the trailing wheels, 17 tons 5 cwt. The train was fitted throughout with the continuous brake. The engine had its foremost (*i.e.*, its proper trailing) axle broken in two places, its coupling-rods fractured, and bogie frame, tanks, and frame, etc., much damaged.

From an examination of the testimony given at the inquiry it is impossible to come to any other conclusion than that the accident was due to the fracture of the foremost axle of the engine, which, as the engine was running bunker first, was the proper trailing axle.

The fracture occurred in the wheel seat close to the collar, which separates the journal from the wheel seat just inside the boss of the right-hand wheel. The appearance of the axle after the accident denoted that there had been a previously existing fracture at this place, extending over about one-quarter of the sectional area of the axle. This previous fracture was apparently fairly recent, but it was clearly anterior to February 28.

Regarding this axle, the breaking of which was the cause of the disaster, it will be seen from the evidence of Mr. Pryce, the Locomotive Superintendent of the North London Railway, that the axle, which was of steel, was 25½ years old, and had run 578,020 miles. It had been under more than one engine, and it was transferred to engine No. 109 in November, 1887, the engine itself having been rebuilt in 1886. In 1889 new tires were fixed on the wheels, and in December, 1892, and in October, 1894, the engine went to the shops at Bow for repairs and for the turning up of the tires of the wheels. On all these occasions—viz., in 1887, 1889, 1892 and 1894—the axle was examined with a view to detecting any flaw that might exist, but no defect was discovered.

The examination on such occasions takes place after the axle has been removed from under the engine. It is carefully cleaned and placed in the lathe, and after it has been exposed to the vibration produced by the cutting tool during the process of turning up the wheels, the surface of it is closely examined with a magnifying-glass. Should it not be necessary for the tires to be turned up, similar vibration can be set up by striking the wheels and axle a heavy blow, or by rolling them along rails and causing them to collide with another pair of wheels or other obstacle, or in some such manner. The effect of the vibration produced by any of the above methods is to cause the oil which has penetrated into the flaw to appear on the surface of the axle in a fine black line, which can be easily detected by the eye with the help, if necessary, of a magnifying-glass.

On February 27—*i.e.*, the day before the accident occurred—the engine was in shed all day for washing out, and engine examiner James Ridgeway examined the wheels and axles, in accordance with his duty, so far as it was possible for him to do so under the circumstances, and with the means at his disposal. All he could do was to tap the wheels and axels with a hand hammer and examine by eye such portions as are visible. Such examination must necessarily be very incomplete, as the journals are concealed and only the centre portion or body of the axle is visible. Moreover, tapping the axle with a hand hammer while the great weight of the engine is resting upon it would probably not set up sufficient vibration to enable a flaw to be detected in it either by sound, or in the manner already described, even where the surface of the axle is visible. As regards the tires of wheels the case is different. A tire is shrunk on to its wheel, but is distinct from it, and a broken tire can be detected by the sound given out by it when tapped with a hammer, even when the weight of the engine is resting on it. At any rate, Ridgeway seems to have made the usual examination of the axles of engine No. 109 on February 27, and so far as he could ascertain, they all appeared to be sound. There can, however, be no doubt whatever that the previously existing partial fracture, which was discovered in the broken axle after the accident, existed on February 27, and was probably at least a month old. But no examination of the axle, such as described above, whether in the workshops or in the shed, and whether the axle was under the engine or not, would disclose a fracture or flaw situated as this was within the boss of the wheel.

Locomotive axles when new are, according to the modern practice of large companies, subjected to tests for tensile strength, ductility, and also to chemical analysis. Some companies also make use of the "drop test"—that is to say, the axles must be capable of sustaining without fracture a certain number of blows from a heavy weight (2,000 lbs. to 3,000 lbs.) falling from a height of 20 ft. or more, the axle being supported in bearings 3½ ft. apart. For these purposes it is usual, when the axles are supplied by contract, for the contractor to provide at his own expense one additional axle in every 50 supplied, and the company's inspector selects and tests any axles he may think proper out of the 51. The axles tested are held to represent correctly the quality of the casts from which they are made. Where practicable, the 50 axles represented by the axle tested are to be made from the same cast of metal. In the case of a less number than 50 axles being ordered or made from the same cast, an end is left on one axle from each ingot, from which test pieces may be cut.

Each company has its own specification as to these tests, but there is not much difference between them. Each axle has a number and the date of its manufacture stamped upon it, and a special register is kept in which are recorded the results of the tests and of the subsequent examinations to which each axle has been subjected.

As regards the examination of old axles, the method adopted by all railway companies is practically the same as that already described. Whenever an engine or tender is lifted, the bearings of each axle are well cleaned, and the journals and other parts subjected to a very careful examination, in the manner already explained, with the view of ascertaining whether there is any indication of a flaw in the material or any other defect. Should anything of the kind, however slight, be discovered, the axle is at once removed.

* Abstract of a report to the Railway Department of the Board of Trade.

In respect of the testing of new axles and the examination of old axles, the practice on the North London Railway is, it is said, similar in all particulars to that adopted by other railway companies, but there is no definite record to show what tests were made 25½ years ago, though it is believed that they were similar to those now in force.

Inquiries have been made from several of the leading railway companies in the kingdom, and by the permission of the locomotive superintendents of the Northwestern and Great Western companies the locomotive works at Crewe and Swindon were visited, so as to learn the methods adopted for the testing of new axles and the examination of old axles, and it is impossible to discover that there is any practicable test at present known which will disclose a flaw in that portion of a locomotive axle which is within the boss of its wheel, and therefore concealed from view.

Doubtless the mileage run by the broken axle is high, but no limit of age either in years or miles has ever been laid down for locomotive axles, though it is usual to subject all engines to a special examination when they have run 250,000 miles, and after every subsequent 100,000 miles. This examination, which is identical with that already described, occurs as a fact on the North London Railway and on most other lines at much shorter intervals, for it is made whenever the tires require to be turned up, which probably takes place after each 40,000 to 60,000 miles run by the engine. And this was the case with the axle that broke on February 28. Its average yearly mileage was about 23,000 miles, and it was examined as stated in 1887, 1889, 1892 and 1894—that is to say, at intervals of two to three years, or of 46,000 to 69,000 miles.

The fractured surface had a crystalline appearance, and there can, I think, be little doubt that both the previous (partial) fracture and the complete fracture of February 28 were due to age combined with the effects of the severe frost.

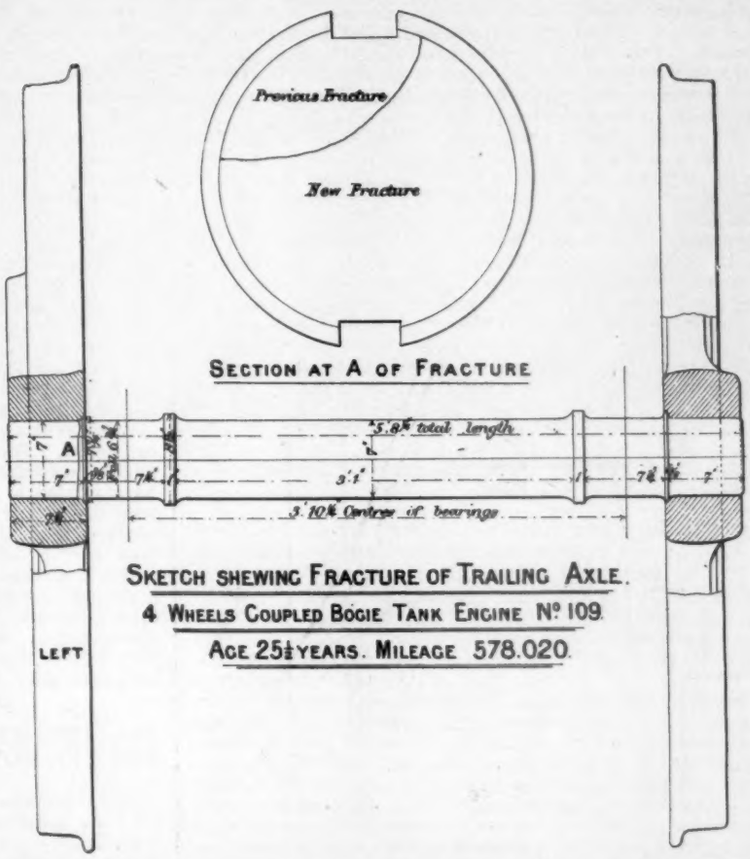
Taking all the above circumstances into consideration, it is evident that no blame can be attributed to any servants of either the Great Northern or the North London Railway companies in connection with this lamentable accident.

It must be admitted that it is somewhat disappointing to find that science has hitherto failed to discover some practical means of testing masses of metal, such as railway axles, for flaws that are concealed from view. The present tests for new axles are extremely valuable, so far as they indicate that the quality of the metal from which a number of axles (perhaps 50) have been made is up to specification and of the highest class, but they do not prove that the whole of the remaining axles, of which the one tested is a sample, are perfect in their manufacture and absolutely free from flaws or defects. And the subsequent examination of axles when taken from under their engines is purely superficial and only capable of detecting flaws which reach the surface, and are not concealed from view.

What seems to be required is some test—possibly by means of electricity, magnetism, or sound—which could be readily applied at suitable intervals to each individual axle, and by which it can be ascertained whether the axle is structurally perfect throughout. Whether such a test is possible no one can say; but the subject seems to be one which is worthy of consideration and of more scientific investigation (as distinguished from the rougher methods of the workshop) than, so far as can be ascertained, it has hitherto received.

It has sometimes been suggested that it is desirable to fix a limit of age, either in years or miles, for all locomotive axles, after reaching which, whether they are apparently sound or not, they should be withdrawn from use. But the locomotive superintendents of railway companies have not as yet seen their way to act upon this suggestion.

It is right to mention that it is now the custom of all the companies with whom communications have been held, including the North London Company, to make the wheel-seat of every axle slightly larger in diameter than the journal and body. In this way the strongest part of the axle is that inside the wheel, and failure of an axle in the wheel-seat is consequently nowadays extremely rare. This modern form of design was not adopted in the axle which led up to the disaster under consideration, and it will be seen from the drawing that the diameter of the wheel-seat was the same as that of the journal and body.



SECTION AT A OF FRACTURE

SKETCH SHEWING FRACTURE OF TRAILING AXLE.
4 WHEELS COUPLED BOGIE TANK ENGINE Nº 109.
AGE 25½ YEARS. MILEAGE 578.020.

THE FIRST STEAM LOCOMOTIVE.

SEEING what an interest is taken in the locomotive by the readers of this journal, it occurred to the writer that some particulars concerning the first practical engine of this kind would be interesting; though, of course, students and others professionally interested may have gathered these particulars before.

It is to Richard Trevithick that credit and honor are due for constructing the first practical locomotive, an engine that was put to practical use and did serviceable work for some time. This was prior to George Stephenson's famous *Rocket* by nearly thirty years, the date of this first engine being 1802. Between this and the advent of Stephenson's invention, Trevithick made two or three others, all practical, one of which was run in an enclosed space near Euston Square, London, as a public exhibition. This was in 1808; but it is recorded to have created so little interest that the shillings taken at the turnstiles did not pay the daily expenses. This latter was run on lines; the earlier ones were not

Trevithick and Watt were engaged at about the same period in inventing and improving on the stationary type of steam engine; but doubtless Watt was the most ingenious, if not the more clever of the two. Where, however, Trevithick excelled and distanced his rival was in proving the efficacy and real value of steam at high pressures. It was this that made the locomotive a possibility, and in the engine as Trevithick made it many of Watt's ideas were swept away. We all know the high value of these latter even at the present day, and it says much for Trevithick's boldness when he put forward an idea for an engine that gave good practical results without them.

At the time named the utility of the condenser, the necessity of the parallel motion, the aid afforded by the vacuum, etc., were so pronounced that to suggest the erection of an engine without them, yet capable of doing greater service, must have seemed foolish.

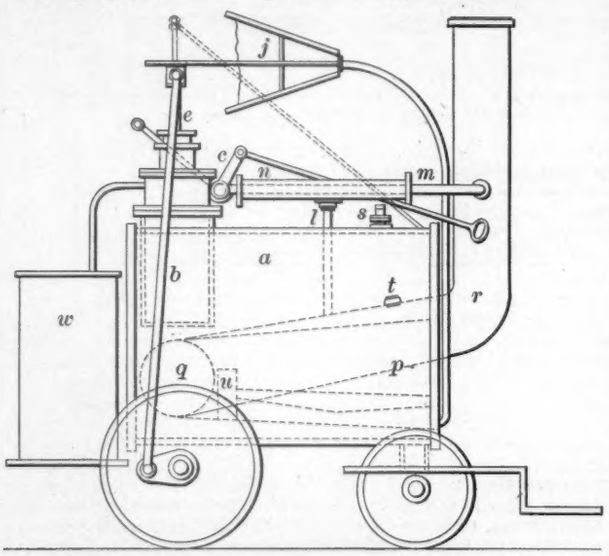
It was the use of steam at high pressures—that is considerably exceeding atmospheric pressure—that made this possible, and it is to be rather wondered at that Watt, with his splendid ideas as a mechanical engineer, did not see it. Instead of this,

he is said to have been a somewhat bitter opponent to the system and its promoter as long as he lived.

The illustration given is of the 1802 engine, which was known as the "Camborne common-road locomotive." No original drawing or complete representation has been handed down to us, this illustration being made up from details and particulars from different sources, and is pronounced, by the compilers of Trevithick's biography, to be correct.

The boiler-shell of this engine *a* was a cast-iron cylinder, with wrought-iron ends. The furnace consisted of a tubular space running from one end to the other, as shown, much resembling the furnace of what is now known as a Cornish boiler. At the end of the furnace bars furthest from the fire door, a bridge, marked *u* in the drawing, was placed, and just beyond this, where marked *q*, the flue took an abrupt turn, coming back to a position beside the fire-door and terminating in the funnel *r*. The furnace is marked *p* just by the fire-door entrance. This was an ingenious method of utilizing a short boiler to advantage, and the gradual reduction in the area of the flue-way insured better flame contact. The multitubular boiler had not been adopted at this time.

The steam cylinder *b* was immersed in the boiler, reaching down very nearly to the furnace tube. This amounted to giving the cylinder a steam jacket, at the same time rendering the engine very compact, as will be seen. Only one cylinder, with its necessary piston, was used, and the piston-rod carried a cross-arm up and down, this arm being connected with the cranks of the driving-wheels on each side by connecting-rods as shown. Steam was admitted to both sides of the piston alternately; but this single piston necessitated the cranks on the driving-wheels being precisely opposite one another whatever their position was, and this gave "dead points" in their worst form. In his next engine he overcame this difficulty by using a fly-wheel driven by a horizontal piston-rod.



THE FIRST STEAM LOCOMOTIVE.

This engine was worked at a steam pressure of 60 lbs. to the square inch, and without a load was capable of making a comparatively fair speed. With a load of about 20 tons it travelled much about the speed our agricultural traction engines now do over indifferent roads, having sharp curves and steep inclines. There was a doubt at first whether the weight of the engine would cause the wheels to firmly grip the road, and the original patent provided for claws or similar devices to insure this if necessary. The "claws," however, were not called into use, though nothing would have been lost by using them, as is evidenced by the diagonal strips on the broad faces of our present-day road-engine wheels. This engine illustrated was never run on rails, consequently means had to be provided to guide it. This was effected by pivoting the smaller pair of wheels, and a handle admitted of the driver operating them.

The water-level in the boiler was kept up by a pump worked by the same cross-arm that worked the connecting-rods to the cranks. The pump is not shown in the illustration; but it was situated beside the upper part of the steam cylinder, and its rod worked in a line and parallel with the piston-rod. It drew its supply of water from the vessel *w* by the curved pipe shown, and discharged it into the boiler through the pipe *l*. An important part, however, was played by the case *n*, which, between the two flanges shown, enveloped the exhaust steam pipe. The feed water entered this case before passing into the boiler, and the consequence was that it became heated by the pipe within. In other words, it was a very creditable feed-water heater.

There has always been something of a controversy as to who originated the idea of discharging the exhaust steam into the funnel. The effect of this, in keeping the fire in its necessary bright and active state, is well known; but the credit of the invention is commonly given to Stephenson, who, with this and a multitubular boiler, made his *Rocket* of greater efficacy than all its competitors. The details of Trevithick's first engine, however, include this important feature, the pipe *m* conveying the exhaust steam from the cylinder to chimney, as shown; a four-way cock at *c*, "worked by tappets," admitting of steam ingress or egress. If this was so, then the question might be asked, Why were the bellows *j* provided? They were worked by the rising and falling piston-rod, and discharged air beneath the fire bars to keep the fuel in an active state of combustion. Trevithick's biographer suggests that the exhaust was not terminated in the chimney in a manner to have an efficient effect, but that this was recognized and overcome in his later engines. Certainly the illustrations of his other locomotives do not include any bellows, and there is little reason to doubt that Trevithick perfected the idea. To insure safety in working, a safety-velve, of the weighted-lever kind, was fixed at *s*, and a soft metal plug (a fusible plug) was put in the crown of the flue at *t*.

Trevithick's genius was undoubtedly of a very high order, for, previous to the locomotive, he was one of the best-known pioneers of the stationary steam engine. He is supposed to have been the first to put tubes in his boilers, cross tubes, which the flame and heat impinged against, greatly improving results. He did not, however, make the tubular boiler which has the flame passing through the tubes. He is also credited by his biographer with inventing the compound engine, in which he, of course, caused the steam from his primary cylinder to pass to a second, and thus do further work before being exhausted. The compound engine and the locomotive could never have been perfected as they are now, even if they could have existed at all, without high pressure steam. This was undoubtedly the greatest invention, in point of subsequent importance and utility, ever made. It is one of the things that even now is becoming of more and greater importance, and which it would be hopeless our attempting to do without. It is strange, however, that, except to a comparative few, Trevithick's name is quite unknown to fame in connection with the steam-engine. Watt's and Stephenson's names have lived, and very rightly, too; but the other man may be just as rightly ranked as equal with them.—*English Mechanic.*

EIGHT-WHEELED PASSENGER LOCOMOTIVE FOR THE ROYAL SWEDISH STATE RAILROAD.

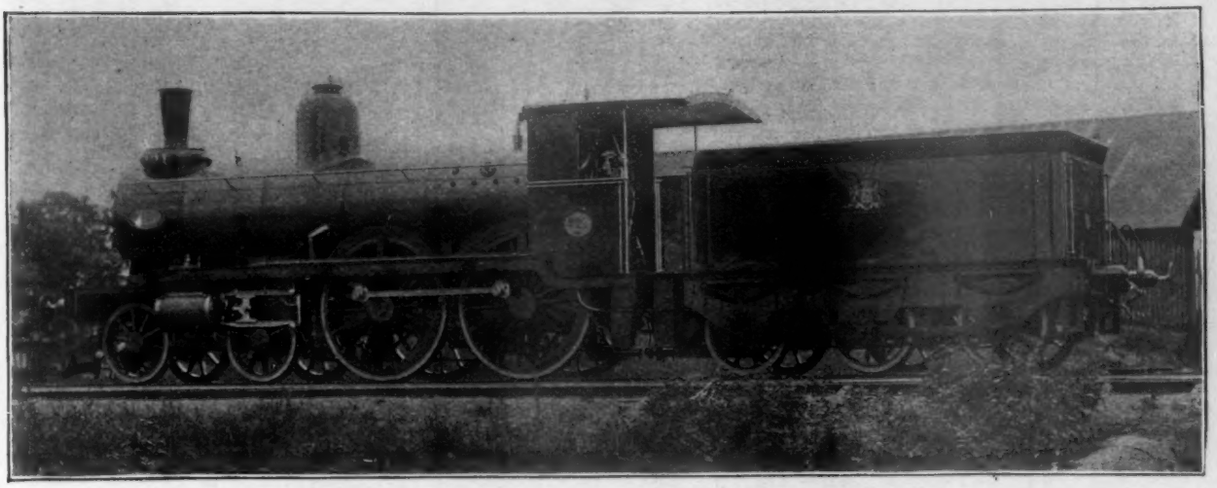
THE eight-wheeled passenger locomotive for the Royal Swedish State Railroad, of which we give very complete engravings, might be run upon almost any railroad of the United States and attract hardly a passing notice from the average observer, though there are some distinctive features to the machine in which it differs from the American locomotive. The most characteristic feature is to be found in the location of the reverse lever and the throttle-valve, which are so placed that the position of the engineer is upon the left-hand side of the engine. The reach rod is operated by a reversing screw in a manner similar to that adopted by most European engineers, which, while it has an advantage over the reversing lever and notched quadrant in the matter of fine adjustments of cut-offs, has the disadvantage of slowness of motion. At the base of the stack, too, there is a collar something like an Elizabethan ruff without the tucks that serves as a cinder catcher in conjunction with the conical flares that surround the top of the exhaust nozzle. The system of equalizing the weight upon the truck wheels is somewhat more elaborate than that to which we are accustomed, and could not be easily applied with a pivoted or bogie truck. It will be noticed, too, that in the equalization of the driving-wheels more weight is put upon the back than upon the forward drivers.

The frame is of the plate type, cut out in the usual European manner for the axle boxes. The valve motion is of the Stephenson type, with straight links; and here, instead of having the link block pivoted on the lower end of the rocker arm, like the prevailing practice in this country, the rocker is set well forward about on a line with the front ends of the guides, and having its upper arm coming close to the glands of the steam-chest stuffing-box. There are two rods running from the link block to the rocker, so that each part is held on both sides, and thus all side strains are avoided. The fire box is of copper, and the grates are of a type that would be novel for

this country. The flat portion near the back sheet and the inclined portion beneath the brick arch are formed of flat bars interlocked as shown on the plan, while the dumping grate at the front end, and upon which the fire can readily be pushed, serves to empty the fire-box.

The connection between the engine and tender is similar to that in use upon the Pennsylvania Railroad. The radial stays of the crown-sheet are flexible in the two front rows, and there is a cross stay for the shell just above the crown sheet. The deflector above the fire-door serves to throw the air admitted above the fire downward, and this, in conjunction with the brick arch, effects a very perfect combustion. The following is a list of the principal dimensions of the locomotive :

Gauge of road	4 ft. 8.6 in.
Total weight of locomotive in working order	87,615 lbs.
" " on driving-wheels	55,462 lbs.
" wheel base of engine	19 ft. 4.29 in.
Distance between centres of front and back driving-wheels	6 ft. 8.31 in.
Distance from centre of main driving-wheels to centre of cylinders	9 ft. 2.03 in.
Transverse distance from the centre of one cylinder to the centre of the other	6 ft. 2.02 in.
Diameter of cylinder	16.54 in.
Stroke " piston	1 ft. 10.05 in.
Diameter " piston rod	2.08 in.
Width of steam port	1.26 in.
" " exhaust port	2.6 in.
Length of ports	13.78 in.
Outside lap of slide valve	.79 in.
Diameter of driving-wheels	6 ft. 2.02 in.
" " truck-wheels	3 ft. 6.91 in.
" " main driving-axle journal	7.48 in.
Length " " " "	7.87 in.
Diameter " truck-axle journal	5.97 in.
Length " " "	7.87 in.
Diameter " main crank-pin journal	4.74 in.
Length " " " "	3.94 in.
Diameter " side-rod crank-pin journal	3.54 in.
Length " " " "	3.15 in.
" " driving springs centre to centre of hangers.	3 ft. 1 in.
Boiler	Straight top.
Inside diameter of smallest boiler ring	4 ft. 4 12 in.
Thickness of plates in barrel of boiler	.51 in.
Kind of horizontal seams	Sextuple riveted, with inside and outside welts.
" " circumferential seams	Double riveted, with outside welts.
No. of tubes	167
Diameter of tubes, outside	1.97 in.
Length " " over tube plates	13 ft. 1.41 in.
Length of fire-box	6 ft. 8 95 in.
Depth " " (front)	4 ft. 10.46 in.
" " " (back)	3 ft. 10.66 in.
Material inside of fire-box	Copper.
Thickness of side plates of fire-box	.51 in.
" " back " " "	.51 in.
" " crown " " "	.51 in.
" " tube " " "	.79 in.
" " front tube plate	.79 in.
How crown sheet is stayed	Radial stays.
Diameter of dome	2 ft. 7 5 in.
Height " "	2 ft. 7.89 in.
Maximum working pressure	150 lbs. per sq. in.
Grate area	21.31 sq. ft.
Total heating surface	1,209.23 sq. ft.
Kind of blast nozzle	Single.
Smallest inside diameter of stack	12 8 in.
Height from top of rails to top of stack	13 ft. 1.48 in.
Width of grate bars	.51 in.
" " air spaces	.43 in.
Height from top of rails to centre of boiler	7 ft. 3.41 in.
Capacity of coal space	6,160 lbs.
" " water tank	3,700 galls.



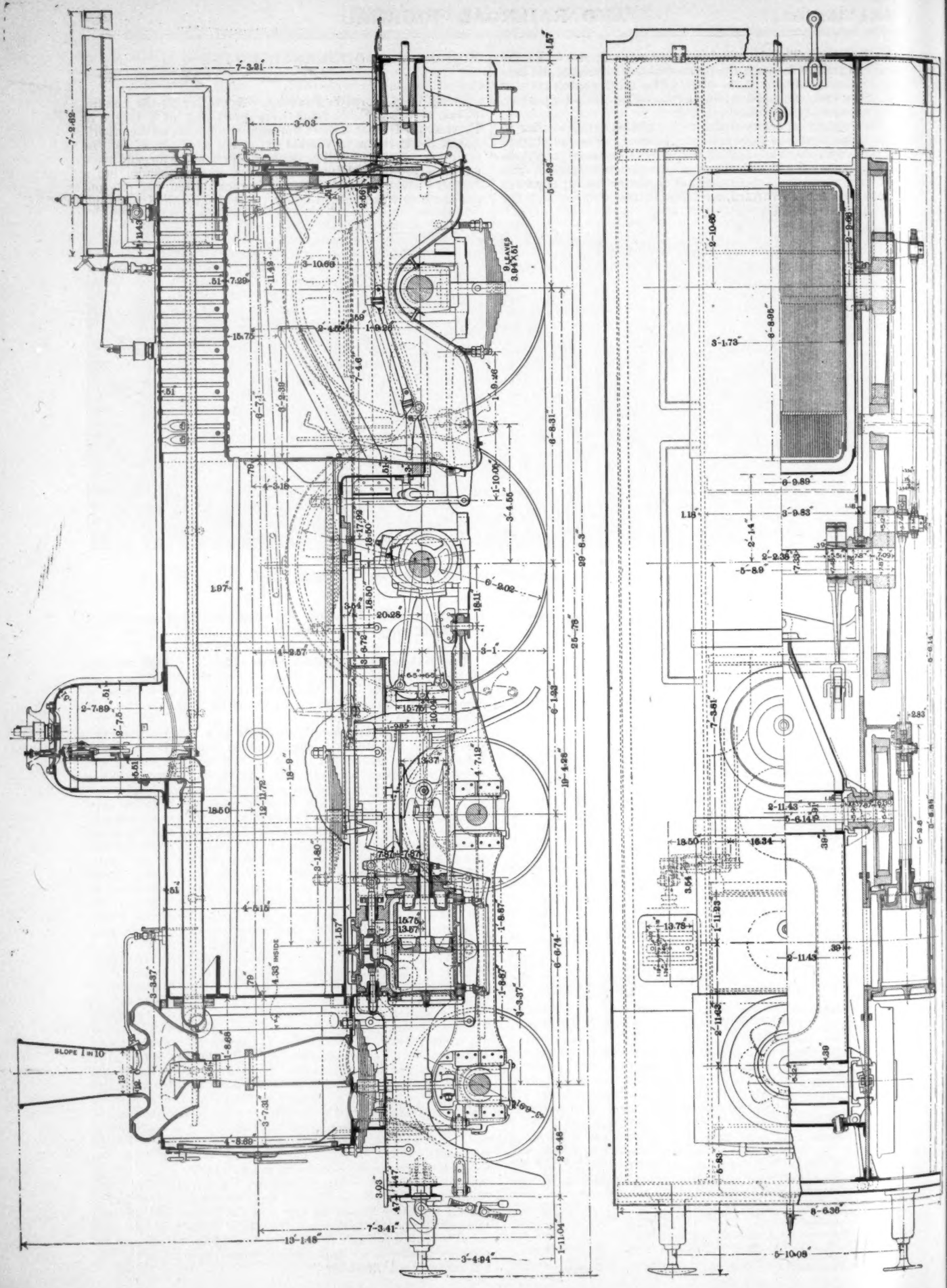
EXPRESS PASSENGER LOCOMOTIVE FOR THE ROYAL SWEDISH RAILROAD.

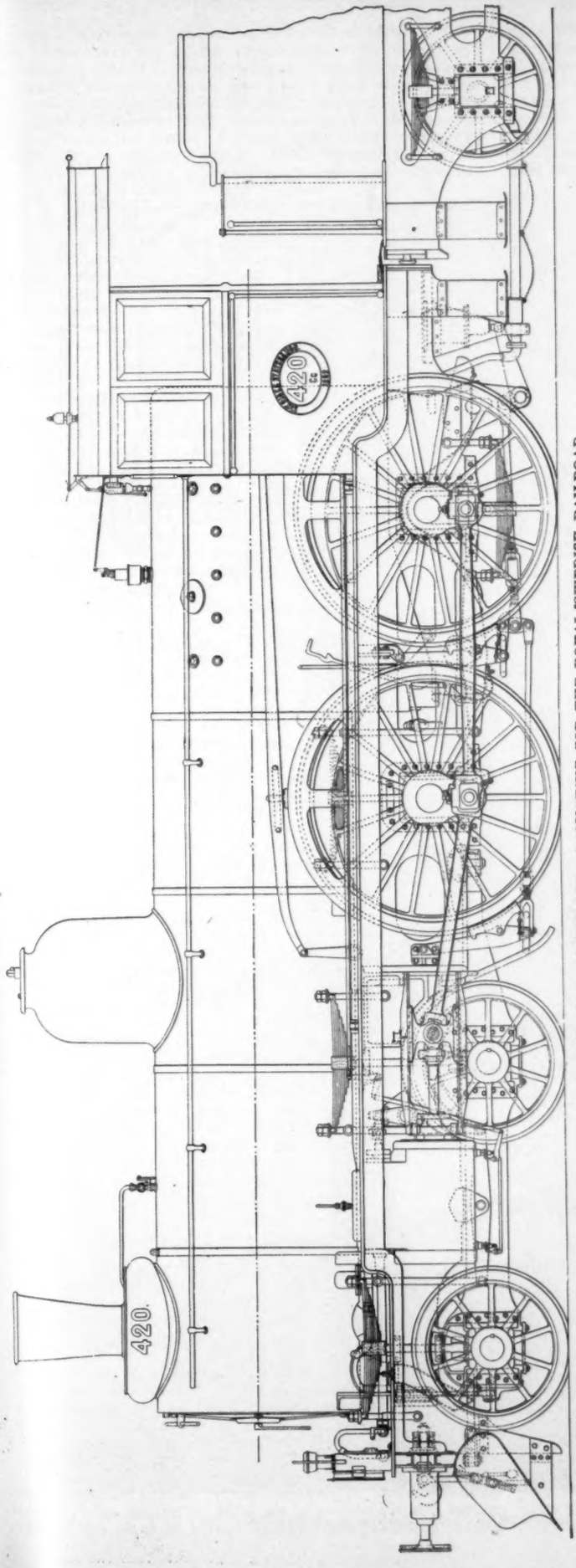
ORDNANCE NOTES.

Dangerous Torpedo Practice.—According to the London *Times*, as two torpedo-boats were practising at a target in Portsmouth Harbor, a short time ago, one got across the other's line of fire as it was in the act of letting off a torpedo. The craft was struck with full force amidships, and the torpedo made a large hole in the plating. The vessel was run ashore, but a further mishap awaited her, as she struck on a sunken pile and another hole was knocked in her. She rapidly filled, and sank in shallow water. The boat was raised and lifted on to one of the jetties, where she will be repaired.

The Efficiency of Modern Guns.—At the annual meeting of Sir W. G. Armstrong, Mitchell & Co., the celebrated gun and ship-builders, Lord Armstrong in his annual address, in commenting on the results of the use of their guns in the Chinese-Japanese War, said :

" So far as we have heard, no single gun was rendered unserviceable except by the enemy's fire ; and in one instance where a gun received a direct hit and was dismounted the breech mechanism was still found to be in perfect working order. We have received very flattering recognition of services rendered, together with important orders for further supplies unvaried in pattern. Thus the prediction so commonly expressed—that, however efficacious the refined and elaborate mechanisms of modern artillery might prove in experimental practice, they would be found disappointing under the exciting and rough usage of actual war—has by this experience been completely falsified, and the possibility of a return to simpler and less scientific constructions has been put entirely out of the question. The first elements in the success of the Japanese were undoubtedly their superior scientific training, organization, and discipline, without which the finest weapons cannot count for much. But after due account has been taken of these qualities, the victory of Japan on the sea must be attributed chiefly to the wise foresight of her naval authorities in arming their ships with quick-firing guns. One gun of this type represents a battery of several guns of the old type, and as now constructed by us their range and penetrative power are unsurpassed. The Japanese, in regard to armament and naval material, kept themselves not only abreast, but, if anything, ahead of their times, and recognized the value of the modern weapons as utilizing to the utmost the higher velocities and lower trajectories rendered possible by the use of cordite. This increased power of guns enabled them to operate at a distance too great to permit of effective reply. The carriages of these guns also deserve some special mention. They are highly finished scientific instruments, utterly different from the rough wooden carriages in vogue not so very long ago, which require 12 or 15 men to manœuvre them. Guns of 10 to 12 tons weight that no one in the old days would have thought of placing on board ship at all can now be trained and elevated easily with a single hand, and, in spite of what might be supposed to be the delicacy of the contrivances by which such results are obtained, no single carriage was disabled in the late war except by a direct hit."


SLOPE 1 IN 10



EIGHT-WHEELED PASSENGER LOCOMOTIVE FOR THE ROYAL SWEDISH RAILROAD.

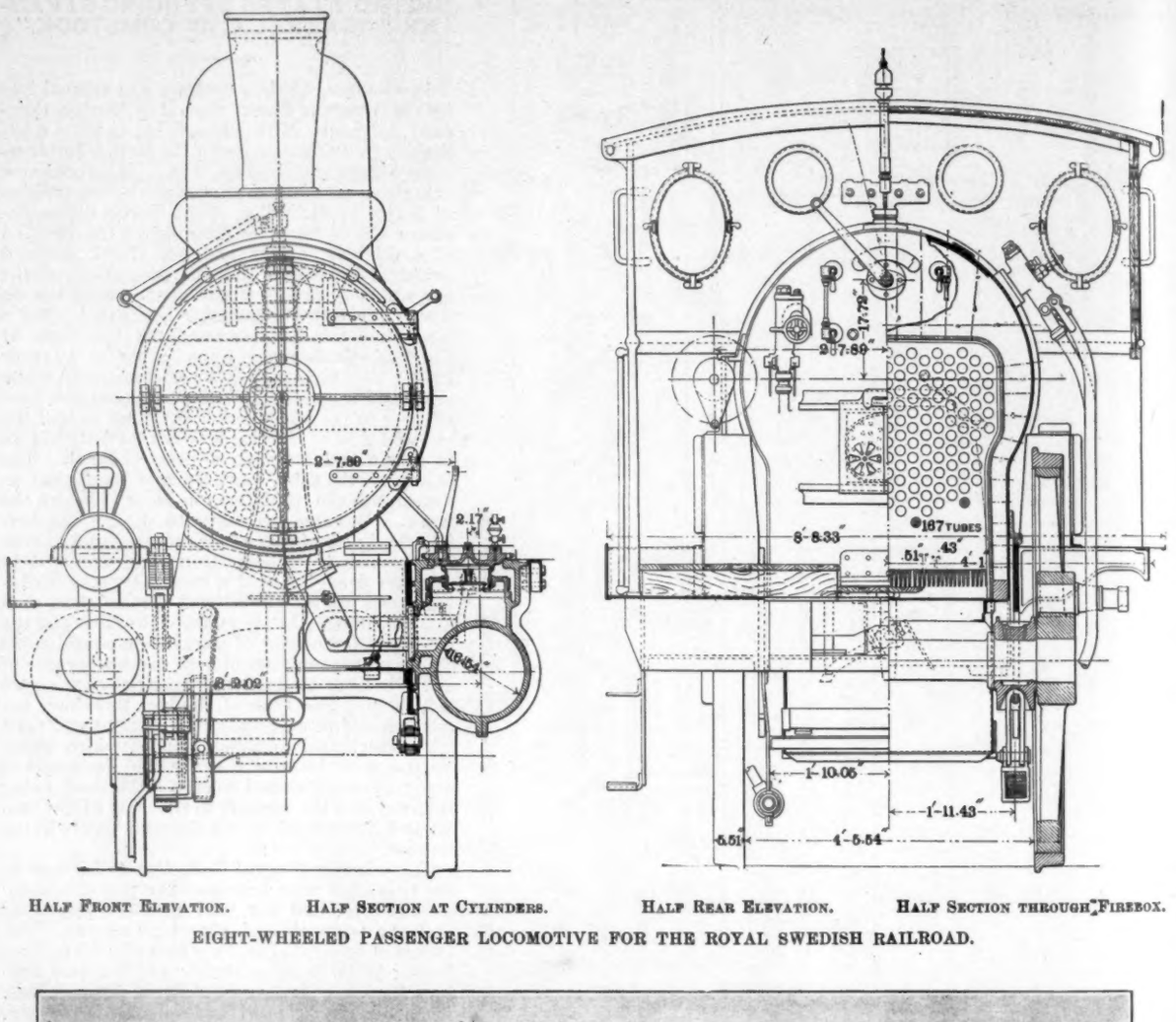
UNITED STATES DREDGING STEAMER "GENERAL C. B. COMSTOCK."

In October, 1894, a contract was entered into by the Bucyrus Steam Shovel & Dredge Company, of South Milwaukee, Wis., to build a hydraulic dredging steamer for the Harbor Improvement Works at Galveston, Tex. The works now being carried out there, under the supervision of Major A. H. Miller, of the United States Engineer Corps, have for their object the creation of a deep-water port, and one of the first and principal necessities was the deepening of the bar which obstructs the entrance to the bay on which the city of Galveston is situated. For a long time this bar has restricted the draft of water of vessels entering the harbor to 10 ft. or 12 ft. The formation is a very fine, hard white sand, and a considerable improvement has been effected by the construction of jetties, so that the ebb and flow of the tide between the jetties helps to create and maintain a deep channel. The action of the tides, however, was insufficient to accomplish the result, and, in order to hasten the work, it became necessary to dredge the bar. The dredging of ocean bars presents a set of conditions entirely different from those met with in ordinary dredging, and a special type of dredging vessel has been developed to meet these conditions. Owing to the exposed situation and the consequent necessity of working in considerable sea-way, it is impracticable to use anchorages of any kind, or to load the material into scows alongside. The type of dredge, therefore, becomes a self-propelling hopper steamer equipped with centrifugal dredging pumps, which pump up the sand from the bar while the vessel is being slowly steamed over it; the sand being received into the hoppers in the hold of the vessel and discharged at sea through valves in the bottom.

The steamer *General C. B. Comstock* is one of the latest and most complete examples of a vessel of this type, and her trial performance shows that she is capable of very high results. The hull is of wood, 177 ft. long over all; 35 ft. 6 in. beam; 16 ft. depth of hold; and the two hoppers have a collective capacity of 500 cub. yds. when filled to level of main deck. They can, however, be filled considerably higher than this, as they are surrounded by a coaming 33 in. high.

The propelling engines drive the vessel at a speed of 10 miles per hour when light and 8 miles per hour when loaded. Steam is furnished by two marine boilers 10 ft. in diameter by 11 ft. 6. in long, each boiler having two Fox corrugated furnaces. Immediately forward of the hoppers is the pump-room. Here are located two independent centrifugal dredging pumps each driven by compound direct-connected engines of 125 H.P. Each pump has 15 in. suction and discharge, and is specially designed to withstand the abrasion and wear of the sand for the greatest length of time, and to give freedom of flow through the passages. The blades are of steel, and are removable through a manhole in the casing. There is a thrust bearing on the shaft of the pump of the multiple collar type, and an intercepting chamber provides for the exclusion of the sand from pump shaft bearing. The cranks are balanced, and the engines run smoothly and steadily at 200 revolutions, but in ordinary work the speed is about 185 revolutions.

The suction pipes enter through the side of the boat just above the load water-line. There is a heavy flanged socket casting fitted into the side of the vessel, which receives the swivel elbow of the suction pipe. This elbow is a steel casting, and has sufficient length of bearing in the socket to hold it in place and take the entire strain of the suction pipe without any additional support. The stuffing-box for the elbow is inside the boat, and easy of access from the pump-room. The suction-pipe is 50 ft. long, in two sections, and made of wrought-iron welded tubing. There are two flexible connections in the pipe to permit



HALF FRONT ELEVATION. HALF SECTION AT CYLINDERS. HALF REAR ELEVATION. HALF SECTION THROUGH FIREBOX.

EIGHT-WHEELED PASSENGER LOCOMOTIVE FOR THE ROYAL SWEDISH RAILROAD.

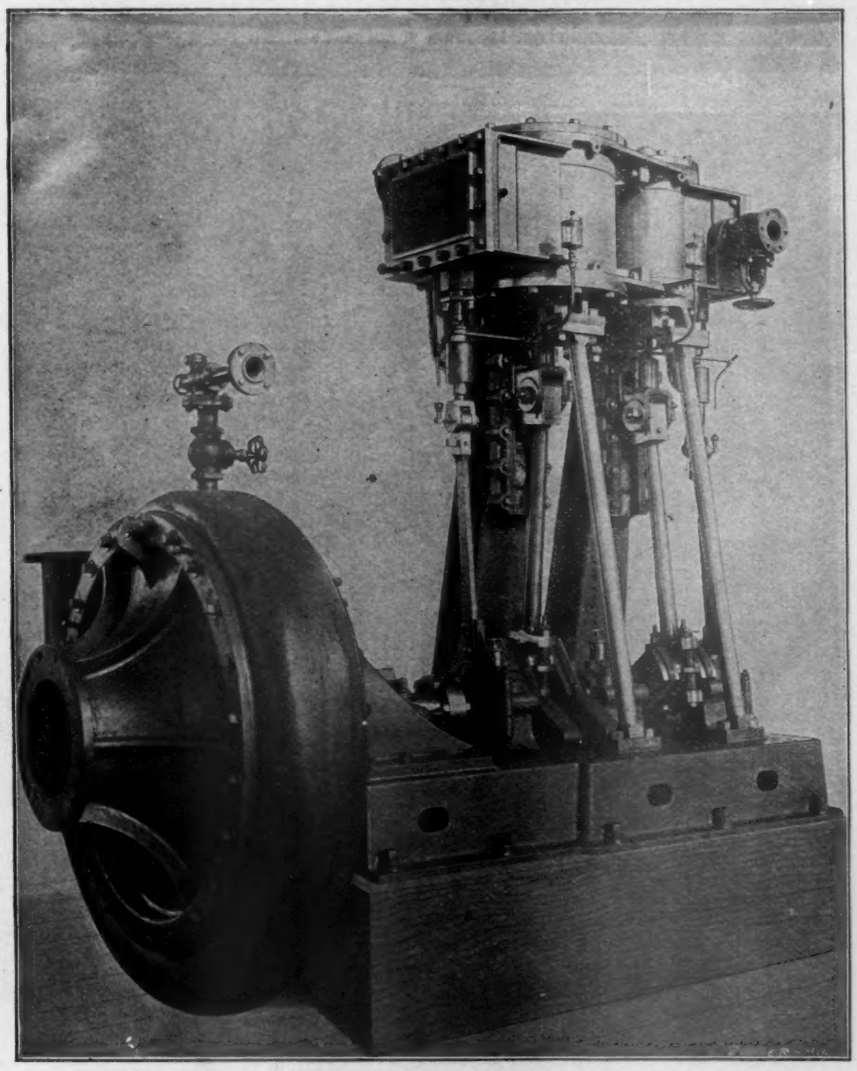
UNITED STATES DREDGING STEAMER "GENERAL C. B. COMSTOCK."

freedom of movement in a seaway under all conditions. The drag at the lower end of the suction pipe is of cast iron, and so arranged that if it should encounter any immovable obstruction it will raise up and pass over it automatically without unduly straining the suction pipe. The suction pipes are suspended on each side from two steam cranes with wire rope hoisting tackle, by means of which they are readily raised or lowered to the required depth. A spring indicator on the crane shows the tension of the ropes and the degree of pressure of the drag upon the bottom. The drag is furnished with removable steel cutting blades.

From the pumps the discharge is carried forward over the hoppers in two large troughs which have openings or slides at suitable intervals, so that the material can be properly distributed in the hoppers. The discharge of the pumps consists of a mixture of sand and water, the percentage of sand varying from 10 to 40, according to circumstances. The water overflows from the hoppers through suitable openings, passing over the deck, while the sand precipitates in the hoppers. During the trial the hoppers were filled with water only in 4½ minutes, with both pumps running. This is equal to a capacity of 11,000 galls. per minute for each pump. The time occupied in opening the valves and discharging the load is 7½ minutes.

The vessel is equipped with Providence steam windlass, Chase steam steering gear, Westinghouse electric light system, Huntington search lights, and a full equipment of everything that goes to make up a complete sea-going vessel. The crews and officers' quarters are ample and commodious and constructed over the hoppers, and are specially designed for a warm climate. Pilothouse and bridge is placed forward. There are two masts, each fitted with derrick booms arranged for handling the suction pipes and all her own machinery. Complete awnings are provided over both forward and after decks.

The propelling engines are by Neafie & Levy Company, of Philadelphia, and the hull was built at the yards of Hugh Ramsay, Perth Amboy, N. J. The vessel steamed to her destination, arriving there August 31, and her trial tests have been satisfactorily completed and the vessel accepted by the Government. The vessel was built from the designs of A. W. Robinson, M. Am. Soc. C. E., who also designed the pumps, pumping engines and dredging equipment, and which were built at the works of his company at South Milwaukee, Wis.



ENGINES OF THE UNITED STATES STEAMER, "GENERAL C. B. COMSTOCK."

A DOUBLE ANGLE-SHEARING MACHINE.

In our issue for May we published an article on the adaptation of the electric motor for certain classes of heavy work, in which an attempt was made to show that there are many cases where heavy work is to be done that it is cheaper and better to take the machine to the work than it is to reverse the process, as we usually find it done. This same principle has been in part applied to the heavy double-angle shearing machine that is made by Hilles & Jones Company, of Wilmington, Del. The machine is not of that portable nature that permits it to be moved about the yard or hoisted to the top of the scrap heap, as we found to be the case with many machines driven by electric motors, but it is set upon a turntable, so that scrap or material can be heaped or piled up in a circle about it and the face of the machine turned opposite that portion of the pile upon which work is to be done, thus avoiding the expense of unnecessary handling, and reducing the time required for the performance of the work to the lowest possible limit.

Our illustrations, which are reproductions of photographs, give a clear idea of the construction. It will be seen that the machine stands upon conical roller bearings having a diameter of 8 ft. at the outer ends. There are 20 of these rollers, and just beneath their lower bearing surface there is a circular rack with which the small hand-operated pinion meshes. This is used for turning the machine, and as this is done so infrequently, the application of power for the purpose is unnecessary. It is at the front, and is clearly seen in the engraving of the front view.

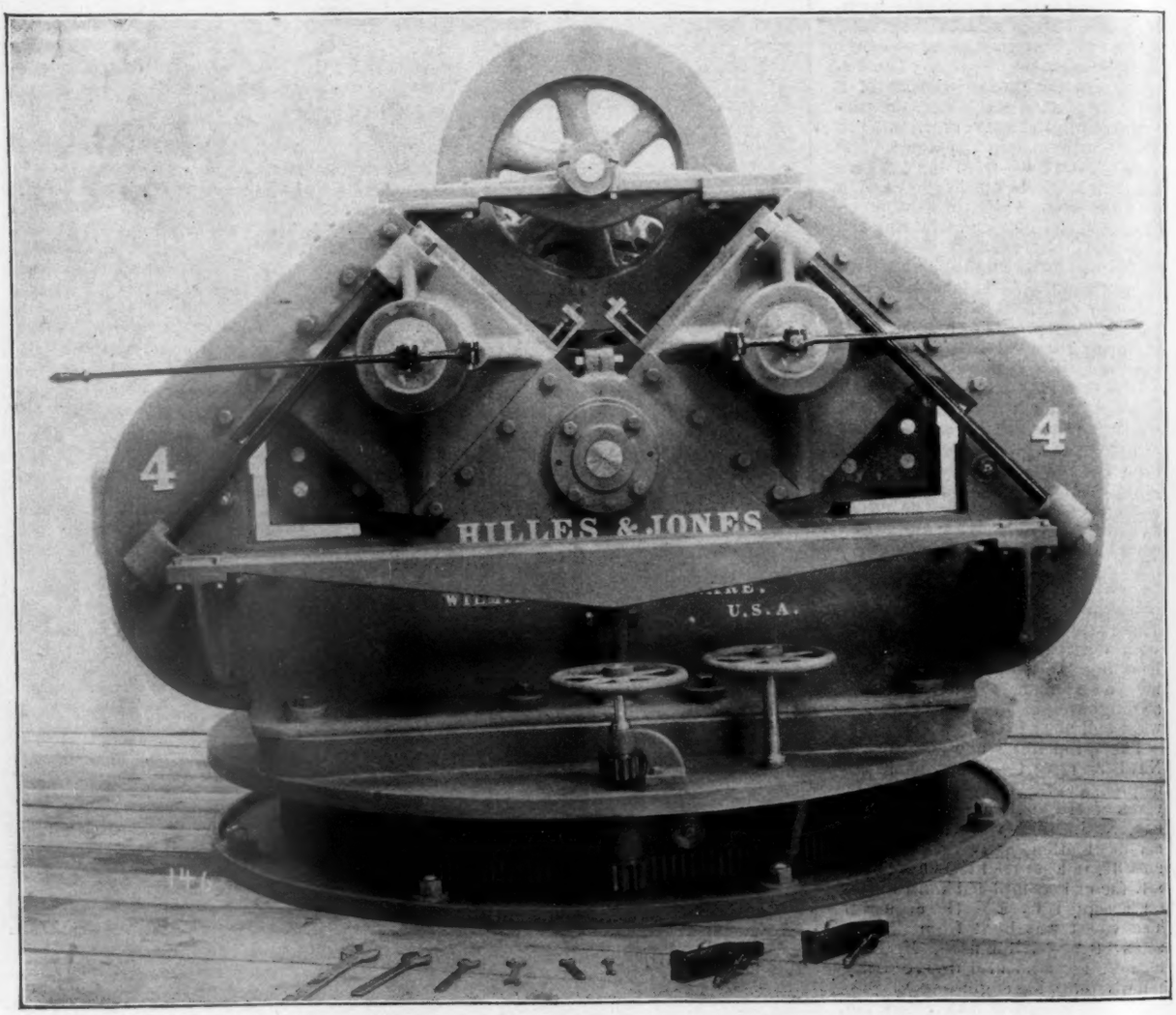
The machine is practically two combined in one, for there are two sliding heads, each working at an angle of 45° with the vertical, and adapted for angle cutting, only one of which, however, appears in the engraving. These cutters are thrown out far enough to one side so that a long bar placed in position will clear all of the working parts at the back. The capacity is equal to the shearing of 8 in. × 8 in. × 1 in. steel angles, which speaks for its strength, while the engraving shows the massiveness of the frame and working parts.

The shears are driven by independent spindles controlled by separate clutches, the engaging lever of one of them being shown over the top of the frame at the right of the rear view, while both are clearly shown in the view from the front. At the back the moving head is counterbalanced by a heavy weight on the driving spindle.

Power is supplied by a self-contained engine having a cylinder diameter of 10 in. and a piston stroke of 12 in., intended to run at a speed of 250 revolutions per minute. Steam is brought to the engine and the exhaust carried away by means of the pip-

ing running in from the centre of the table. This engine is bolted to the back framing, and can thus be easily removed for repairs. With the arrangement of steam pipes employed, the use of any overhead steam pipes is entirely done away with and the machine can be placed in any part of the shop with entire freedom for the crane to travel over it. The revolving table is 10 ft. in diameter, thus forming a large and substantial base plate, upon which the weight of the machine rests; a weight which, with the table itself, amounts to about 50,000 lbs.

The gearing shown consists of a pinion on the engine shaft driving a spur gear on an intermediate shaft that in turn through a hooded pinion drives the two spur gears on the spindles. The teeth of these gears are naturally very heavy, the face being 12 in. and the pitch 3 in.



DOUBLE ANGLE-SHEARING MACHINE, BUILT BY HILLES & JONES COMPANY, WILMINGTON, DEL. FRONT VIEW.

MARINE NOTES.

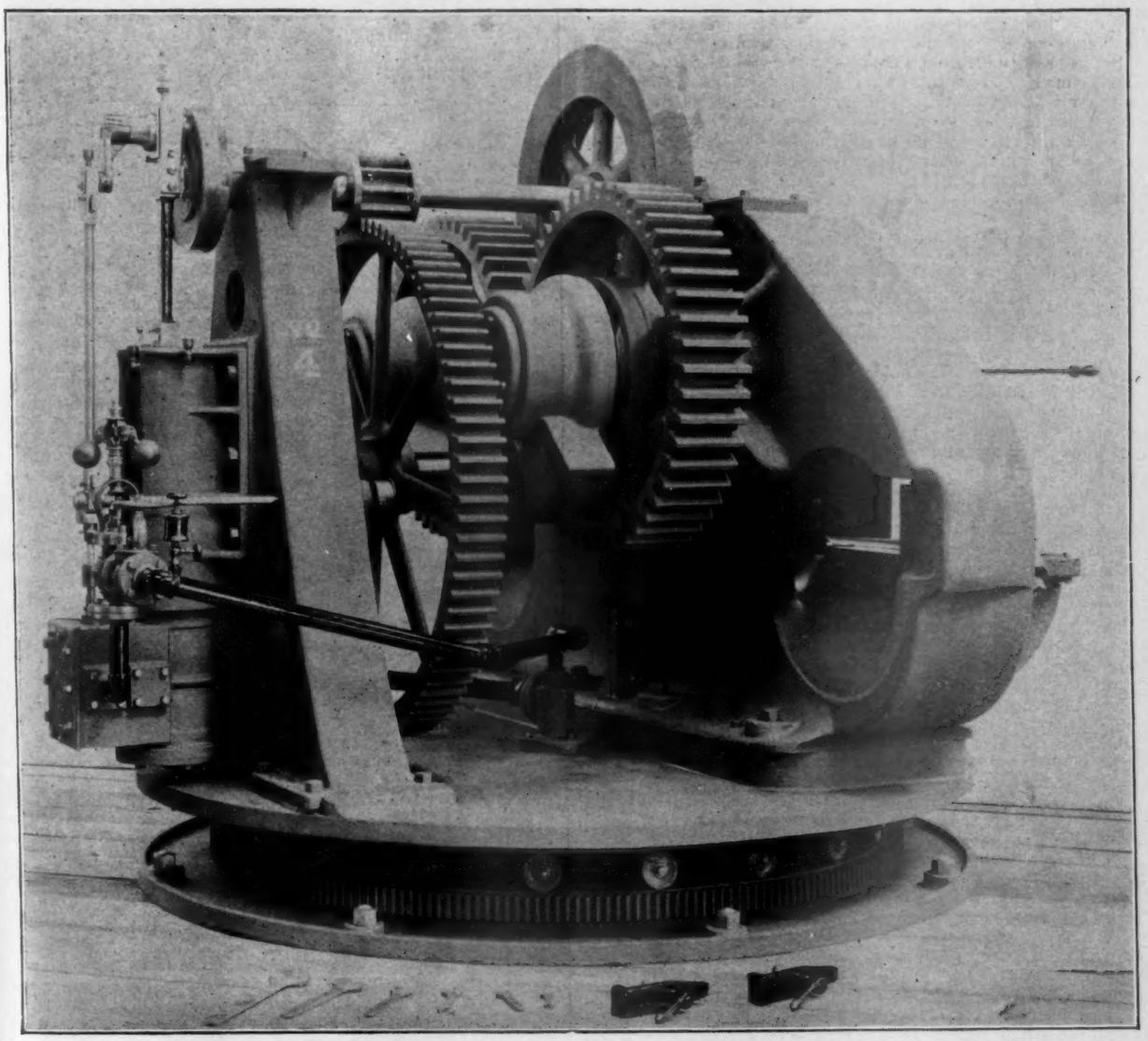
Cadet Engineers from Scientific Schools.—According to a correspondent of the New York *Sun*, "Congress will be asked, probably at the coming session, to pass a law allowing graduates of institutes of technology and similar scientific schools to be appointed as cadet engineers in the Navy, provided they have shown an aptitude for naval engineering, and provided also those institutions establish an engineering course satisfactory to the Chief of the Bureau of Steam Engineering and to the Secretary of the Navy. On being appointed, such graduates would be sent to sea for two years, and would also receive special instruction suited for their proposed calling, and then would be appointed assistant engineers, should they pass a satisfactory examination, or otherwise would be discharged with a year's pay."

The object of this proposed measure is to secure more engineers for the Navy, the academy at Annapolis not yielding enough, as the majority of cadets prefer the line if they can get it.

New Torpedo-boat Destroyer "Sokol."—The London *Times* gives an account of the launching, on August 22, of this boat—the name of which in English means Hawk—from the shipyard and engine works of Messrs. Yarrow & Co. The boat has been built by that firm for the Russian Government. She is 190 ft. long, 18 ft. 6 in. beam, and has a displacement of about 240 tons, is the first destroyer in which nickel steel has been adopted as the material of construction, it having about 30 per cent. greater strength than the ordinary mild steel usually employed. She is fitted by her builders with their special type of twin-screw triple-expansion engines to indicate about 4,000 H.P., and estimated to give her a speed of 29 knots, the steam for driving them being supplied at a pressure of 200 lbs. per square inch by eight Yarrow water-tube boilers, having straight steel tubes, of which a large number have now been adopted in similar vessels for the British Government.

The *Sokol* was launched with engines, boilers, and all auxiliary machinery in place, and within an hour from taking the water had steam up and her engines in motion, followed

by her attaining, when going through a series of preliminary trials, a speed which is unprecedented in the records of any similar vessels in this or any other country. At 2 P.M. on Friday the vessel was on the stocks, at 8 A.M. on Saturday she left Messrs. Yarrow's works and proceeded down the river, and, on reaching the Maplins, increasing speed trials were undergone, giving as results: First speed, 25.8; second, 27.8; third, 29.26; fourth, 30.285 knots, these being in each case the mean speed attained on each set of runs made, the highest speed being realized with 416 revolutions of the engines per minute and the very moderate steam pressure of 170 lbs. per square inch at the boilers, the air pressure never exceeding $1\frac{3}{16}$ in. of water.



DOUBLE ANGLE SHEARING MACHINE, BUILT BY HILLES & JONES COMPANY, WILMINGTON, DEL. REAR VIEW.

PROCEEDINGS OF SOCIETIES.

Master Car-Builders' Association.—The committee on the Location of Air-Brake Cylinders on Freight Cars, having in view easy access in cleaning and repairing, have sent out a circular of inquiry for information and recommendations.

"In view of the large number of cars now equipped with air brakes, which number is being added to daily, the necessity of repairs to these parts is increasing, and is becoming an important factor in the interchange of cars. Therefore the best methods of applying the air-brake apparatus to facilitate the repairs and care of such parts, and avoid delays to cars or freight at terminals and in freight yards, should receive careful consideration. The committee therefore believes that all members fully appreciate the importance of this question, and, with a view of obtaining best results possible, respectfully asks all members of the Association to assist the committee as far as possible by answering this circular at an early date, and giving any and all data which might be beneficial to the committee and assist it in making report."

The questions asked are:

"1. What, in your opinion, is the best location for air-brake cylinders and reservoirs on the following classes of cars, having in view easy access for cleaning and repairing, as well as protecting air-brake apparatus as much as possible in case of derailment: Hopper bottom coal cars, box and stock cars, drop bottom gondolas, straight bottom gondolas?

"2. Do you recommend that cylinder be located low enough so that rods will clear needle beams, or do you recommend cutting passage through needle beam for rods?

"3. Do you consider it an advantage in regulating the braking power to have the rod from the cylinder lever to truck lever stand parallel with the car? Also give your opinion as to the necessity for having the rod between the cylinder and floating lever stand in a line parallel with the car.

"4. What distance would you recommend between needle beams and cylinders to give easy access for repairs and cleaning? What distance between triple valve and needle beam?

"5. What, in your opinion, is the best practice in applying release valves on coal cars?

"6. Has your experience demonstrated whether the water

dropping on apparatus after passing through the coal on coal cars has any damaging effect on the brake apparatus by reason of the chemical properties in the coal?

"7. Please give drawing, sketch, or any other information on the subject which, in your opinion, might aid the committee.

"Please send your answer to the chairman of the committee, James Macbeth, M. C. B., New York Central & Hudson River Railroad Company, East Buffalo, N. Y."

A Military Bicycle Association.—The first annual convention of the United States Military Wheelmen was held at the Broadway Central Hotel recently. It was called for the purpose of inviting all the officers and soldiers and ex-officers and soldiers of the regular or volunteer armies of the United States or of the National Guards of the various States who are wheelmen to meet and express their views in relation to the utility of the bicycle for military manœuvres. This is a new organization, in which it is proposed to unite wheelmen who have a knowledge of military drill into bodies of such size as to test the practicability of moving and manœuvring large bodies of troops with the bicycle.

Addresses were made by prominent military men. The topics discussed were: The proper weight of the military bicycle; proper arms for cyclists; what weight of clothing should be carried? the cyclist as a topographer; should the gun be on the machine or man? should the military machine have a brake? machine guns carried on tricycles; the steam carriage as a practical military machine; foreign governments and the like; should the United States Government establish a bicycle corps?

Major Geddings, of Connecticut, reported that the National Guard in his State had organized a wheeling corps, and have experimented with the bicycle extensively in connection with military tactics with very promising results.

The consensus of opinion in relation to the weight of the bicycle for military use favored 20 lbs. to 25 lbs. The tires for military bicycles, it was conceded, should be pneumatic, and heavier than the ordinary tire. Regarding the proper gun equipment of the military cyclist, different opinions were ventured. Some suggested the use of revolvers, to be carried on the person of the rider, with all other arms strapped to the machine within convenient reach for quick action.

The meeting was in session throughout the day and evening, when papers were read on the relation of the bicycle to the army. It was admitted that for courier service, picket, and scouting duties the bicycle will prove to be a valuable and indispensable adjunct to the army. General Nelson A. Miles spoke at length upon the bicycle and its military advantages, and said that military men were always slow to adopt new improvements. Flint locks survived in the Mexican War years after the percussion cap had been invented, and the army went into the War of Secession with muzzle-loaders, while long before hunters had used breech-loaders. The question is: How far can we use it for military purposes? We have seen enough to convince many men that it will be one of the most useful appliances in war. I have heard it said that you cannot manœuvre large bodies of men on bicycles. I have heard men make that statement, but there are some men who couldn't manœuvre large bodies of men on horse, foot, bicycle, or any other way. Bicycles can be used by men who believe in the bicycle; who have confidence in it, and know that it can be used for war purposes. It can be used in some places where a horse cannot be used. The horse can be used in some places where the bicycle cannot be used. You cannot swim a river on a bicycle, but you can conceal it there for several days, fish it up, and ride away, which you cannot do with a horse. There are many uses and means to which you can apply a bicycle where you cannot use a horse, and where a man cannot perform the same service on foot.

General Albert A. Ordway, District of Columbia Militia, was elected President. Verily the world moves!

PERSONALS.

MR. COLEMAN SELLERS and his son HORACE announce that they have removed their engineering office to Rooms 537–539 Philadelphia Bourse, in Philadelphia.

MR. H. B. HODGES has been appointed Superintendent of Tests of the Southern and Alabama Great Southern Railway companies, with an office at 1300 Pennsylvania Avenue, Washington, D. C. He will provide specifications for and have charge of the inspection of all supplies, except ties and lumber, purchased for the various departments of the system, and will arrange for such mechanical and chemical tests as may be necessary to insure the fitness of the material for service. He will send his reports of such inspections and tests to the general storekeeper, and no new material purchased under specifications shall be issued unless accepted by the superintendent of tests. He will conduct all investigations of and experiments with new devices and appliances referred to him for this purpose by heads of departments, including such tests as are made in the company's laboratories, as well as in actual service on the road, and will furnish the results of such investigations to officers interested. He will investigate, when requested, the failures of rails, wheels, axles, etc., and the cause of hot boxes. All waters used will be analyzed in the company's laboratory, and no changes in the supply will be made except upon favorable report from the superintendent of tests. He will carry out any scientific investigation, and perform such other duties as may be assigned him by the second vice-president, and will report to that officer.

FORTY MILES DEEP.

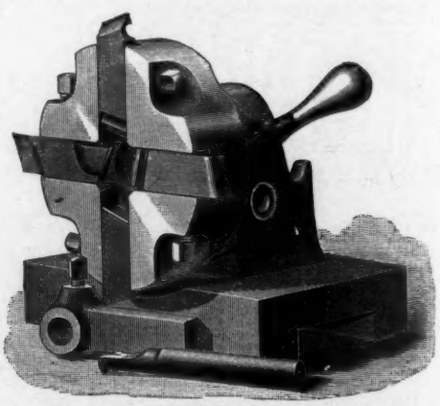
To the Editor of THE AMERICAN ENGINEER:

"Seeing that the atmosphere is 40 miles deep all around the globe," says Horace Mann, it is a useless piece of economy to breathe it more than once. As it is, we are prodigals of health, of which we have so little, and niggards of air, of which we have so much. Sixty passengers in an ordinary car will breathe all the air contained in the car in one and one-third minutes. A method of replacing all the air in a car, and that without draft, dust, or cinders every minute, and withdrawing the vitiated air at the same time, would seem a blessing to every traveller on railroads. Yet this has been done, and several cars on the Boston & Maine Railroad have been fitted with a system of ventilation which accomplishes just the above conditions. These cars are warmer in winter and cooler in summer than ordinary cars by 11°. The cost of application is nothing additional in building new cars, and can be readily applied to old cars at a small cost. No attention whatever is required in this arrangement. The air comes in and goes out, and the headache, dull feeling, sleepiness which is induced by breathing carbonic acid gas is entirely absent in these cars. Let us have health and comfort when it costs nothing at least.

C. M. FULLER.

RICHARDS' ROTARY TOOL-HOLDER.

THIS tool-holder, which is made by Mr. I. P. Richards, of Providence, R. I., is designed to take the place of the common tool-post for engine lathes. It consists of a circular head with radial channels cut in its face for holding a number of different tools at once, which may be set in different positions, so as to finish the work without any changing. Each tool is held independently of the others by its own set screw, as shown in the engraving. It can thus be raised or lowered or run in or out as the work to be done may require. Another important feature for some cases is that the tools can be ground without



RICHARDS' ROTARY TOOL-HOLDER.

changing their position or shape, which will greatly facilitate such work as screw cutting, etc., or when special tools that should not be moved until the work is finished are used.

With this revolving head no time need be lost in changing either the work or the tools, as each tool is quickly brought into position when required. The holder illustrated is one that is intended for use on a lathe having a swing of 16 in. The head is 6 in. in diameter, and the channels will receive 1 in. steel for tools.